THE BULLETIN

OF THE

AMERICAN CERAMIC SOCIETY

Volume 18 JANUARY, 1939 Number 1

STANLEY G. BURT

For story, see page 33

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THE BULLETIN OF THE AMERICAN CERAMIC SOCIETY

Volume 18 **January, 1939** **Number 1**

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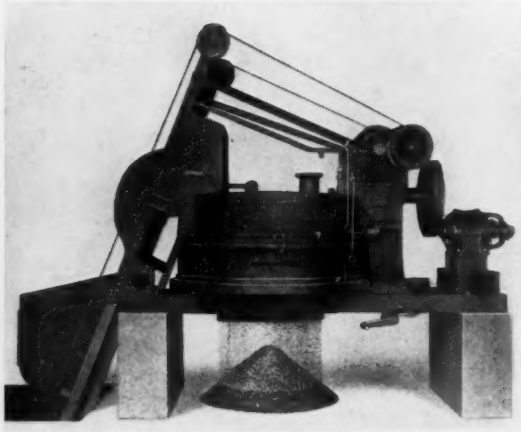

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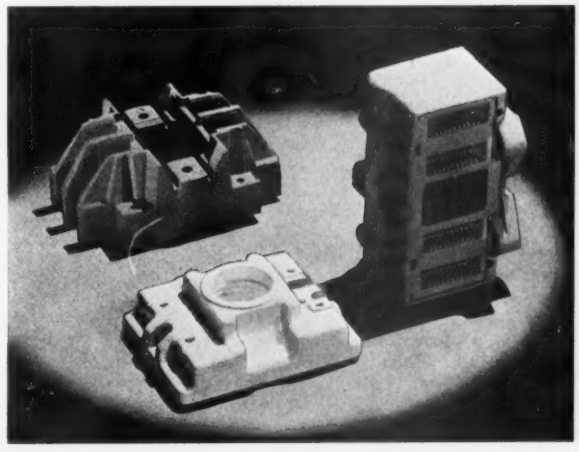

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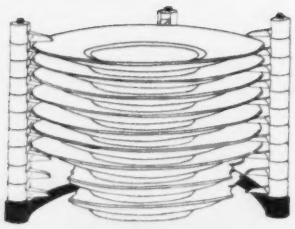

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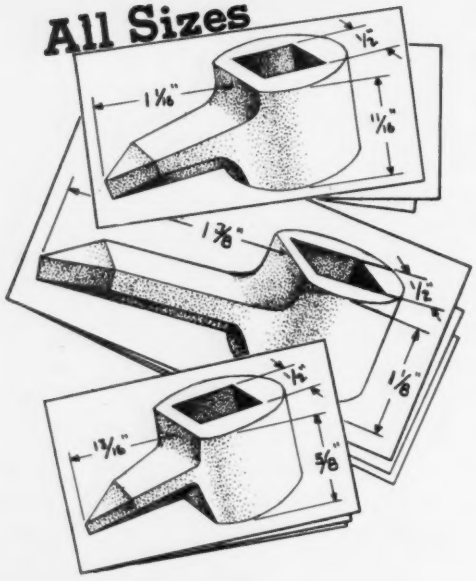

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Kentucky Clay Mining Co.
The Porcelain Enamel & Mfg. Co.
The Vitro Mfg. Co.
United Clay Mines Corp.

Clay Miners
Paper Makers Importing Co.
Spinks, H. C., Clay Co.
United Clay Mines Corp.

Clay (Potters)
Denver Fire Clay Co.
Hammill & Gillespie, Inc.
The Hommel Co., O., Inc.
Kentucky Clay Mining Co.
Paper Makers Importing Co.
Spinks, H. C., Clay Co.
United Clay Mines Corp.

Clay (Process Equipment)
Lancaster Iron Works, Inc.

Clay (Sagger)
The Hommel Co., O., Inc.
Kentucky Clay Mining Co.
Paper Makers Importing Co.
Potters Supply Co.
Spinks, H. C., Clay Co.
United Clay Mines Corp.

Clay-Slip (Albany)
United Clay Mines Corp.

Clay (Wad)
Kentucky Clay Mining Co.
Potters Supply Co.
Spinks, H. C., Clay Co.
United Clay Mines Corp.

Clay (Wall Tile)
Hammill & Gillespie, Inc.
Kentucky Clay Mining Co.
Paper Makers Importing Co.
Spinks, H. C., Clay Co.
United Clay Mines Corp.

Cleaners
Pennsylvania Salt Mfg. Co.
The Porcelain Enamel and Mfg. Co.

Cleaners, Chemical
Harshaw Chemical Co.
Pennsylvania Salt Mfg. Co.

Clocks (Gauge Board)
Chicago Vitreous Enamel Product Co.
The Hommel Co., O., Inc.

Cobalt Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

Cobalt Sulphate
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Colors
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

Concrete (Chutes, Grouters)
Ransome Concrete Machinery Co.

Cones
The Edward Orton, Jr., Ceramic Foundation

Conveying Equipment
Frazier-Simplex, Inc.
Lancaster Iron Works, Inc.

Copper Oxide
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Corhart
Corhart Refractories Co.

Cornwall Stone (Imported)
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Paper Makers Importing Co.

Crucibles (Filter, Melting, Ignition)
Carborundum Co.
Denver Fire Clay Co.
Norton Co.
Potters Supply Co.

Crushers (Clay)
Lancaster Iron Works, Inc.

Cryolite (see Kryolith)
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Pennsylvania Salt Mfg. Co.
The Vitro Mfg. Co.

Crystolon (Refractory Products)
Norton Co.

Cullet, Washing Plants, Incinerators, Crushers
Frazier-Simplex, Inc.

Cutters (Bar)
Ransome Concrete Machinery Co.

Decorating Supplies
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Disintegrators
Lancaster Iron Works, Inc.

Dryer (Pipe Rack)
Lancaster Iron Works, Inc.

Drying Machinery
Frazier-Simplex, Inc.
Lancaster Iron Works, Inc.
Proctor & Schwartz, Inc.

Electrocast Refractories
Corhart Refractories Co.

Enameling Equipment (Complete)
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Frazier-Simplex, Inc.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Enameling Furnaces
Carborundum Co.
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Electro Refractories & Alloys Corp.
The Hommel Co., O., Inc.
Lancaster Iron Works, Inc.
Norton Co.

Enameling Iron (Sheet)
American Rolling Mill Co.
Bethlehem Steel Co.

Enameling Muffles
Bethlehem Steel Co.
Carborundum Co. (*Carbofrax*)
Chicago Vitreous Enamel Product Co.
Electro Refractories & Alloys Corp.
Frazier-Simplex, Inc.
Norton Co. (*Alundum*)

Enameling (Practical Service)
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
The Hommel Co., O., Inc.
Metal & Thermit Corp.
The Porcelain Enamel & Mfg. Co.
The Vitro Mfg. Co.

Enamels
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

Enamel Oxide
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.

Enamels (Porcelain)
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
The Hommel Co., O., Inc.
The Porcelain Enamel & Mfg. Co.
The Vitro Mfg. Co.

Equipment (Porcelain Enameling)
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
The DeVilbiss Co.
The Hommel Co., O., Inc.

Exhaust Systems
The DeVilbiss Co.

Feldspar
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Paper Makers Importing Co.
The Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

Filter Fabrics
Metakloth Company

Fire Brick
Carborundum Co.
Corhart Refractories Co.
Denver Fire Clay Co.
Electro Refractories & Alloys Corp.
Norton Co.

Fire Brick—Process Equipment
Lancaster Iron Works, Inc.

Fire Clay
Denver Fire Clay Co.
Spinks, H. C., Clay Co.

Flint
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Paper Makers Importing Co.
The Porcelain Enamel and Mfg. Co.

Flint Pebbles
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Floors (Non-Slip)
Norton Co.

Fluorspar
Harshaw Chemical Co.
The Hommel Co., O., Inc.

French Flint
Paper Makers Importing Co.

Frit
Allied Engineering Co.
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Porcelain Enamel & Mfg. Co.
The Vitro Mfg. Co.

Frosting Mixtures
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Fuel Oil Systems and Control, Stokers
Bethlehem Steel Co.
Frazier-Simplex, Inc.

Furnaces
Allied Engineering Co.
Carborundum Co. (*Carboradiant*)
Chicago Vitreous Enamel Product Co.
Denver Fire Clay Co.
Frazier-Simplex, Inc.
The Hommel Co., O., Inc.
Swindell-Dressler Corp.

Furnaces-Enameling
Swindell-Dressler Corp.

Glass Bending Ovens, Glass Decorating Machines
Frazier-Simplex, Inc.

Glass Equipment
Hartford-Empire Co.
Lancaster Iron Works, Inc.

Glass Melting Tanks and Furnaces
Frazier-Simplex, Inc.

Glass Thickness Gauge
Bausch & Lomb Optical Co.

Glaze and Body Spar
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc. R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Paper Makers Importing Co.
The Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

Glazes and Enamels
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Porcelain Enamel & Mfg. Co.
The Vitro Mfg. Co.

Glaze Spar
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc. R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Paper Makers Importing Co.

Goggles
The Hommel Co., O., Inc.
Willson Products, Inc.

Gold
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Gold Decorations
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.

Granulators
Lancaster Iron Works, Inc.

Grinding Wheels
Carborundum Co. (*Carborundum and Aloxite*)
Chicago Vitreous Enamel Product Co.
Norton Co. (*Alundum-Crystolon*)

Hearths
Carborundum Co.
(*Carbofrax* heat treating)
Corhart Refractories Co.
Electro Refractories & Alloys Corp.
Norton Co. (*Crystolon*)

Hearths (Fused Al_2O_3, SiC)
Electro Refractories & Alloys Corp.

Hearths (High Aluminous Clay, Electrically Sintered Aluminum Oxide, Silicon Carbide)
Carborundum Co.
Norton Co.

Hoppers (Floor, Tower)
Ransome Concrete Machinery Co.

Hose (Air and Fluid)
The DeVilbiss Co.

Hydraulic Propellers
Denison Engineering Co.

Hydrofluoric Acid
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Iron Chromite
Harshaw Chemical Co.

Iron (Enameling)
American Rolling Mill Co.
Bethlehem Steel Co.

Iron Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

Kaolin
Ceramic Color & Chemical Mfg. Co.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Paper Makers Importing Co.
United Clay Mines Corp.
The Vitro Mfg. Co.

Kellog AA Refractories
Electro Refractories & Alloys Corp.

Kilns, China (Decorating)
Allied Engineering Co.
Denver Fire Clay Co.
Drakenfeld, B. F., & Co.
Frazier-Simplex, Inc.
The Hommel Co., O., Inc.
Swindell-Dressler Corp.

Kilns-(Electric, Circular, Tunnel)
Allied Engineering Co.
Swindell-Dressler Corp.

Kiln Furniture (Silicon Carbide, Semi-Silicon Carbide) (Refractory)
Electro Refractories & Alloys Corp.
Louthan Mfg. Co.

Kyanite
Celo Mines, Inc.

Kryolith (see Cryolite)
Pennsylvania Salt Mfg. Co.

Laboratory Ware
Norton Co.

Lehr Tile (High Aluminous Clay, Electrically Sintered Aluminum Oxide, Silicon Carbide)
Carborundum Co.
Electro Refractories & Alloys Corp.

Lehrs
Frazier-Simplex, Inc.
Swindell-Dressler Corp.

Lehrs (Electric or Fuel Heated)
Frazier-Simplex, Inc.
Swindell-Dressler Corp.

Lehr Loaders
Frazier-Simplex, Inc.

Linings (Furnace Refractory, Block Refractory Plate, Brick and Tile)
Carborundum Co.
Chicago Vitreous Enamel Product Co.
Corhart Refractories Co.
Denver Fire Clay Co.
Electro Refractories & Alloys Corp.
Norton Co.
The Vitro Mfg. Co.

Lithium Carbonate
Drakenfeld, B. F., & Co.
Foote Mineral Co.

Lithium Minerals
Foote Mineral Co.

Magnesia (Fused)
Electro Refractories & Alloys Corp.
Norton Co.

Magnesia (Sintered, Calcined)
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Porcelain Enamel and Mfg. Co.

Magnesite
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Magnesite Calcined
Foote-Mineral Co.
The Hommel Co., O., Inc.

Magnesium Carbonate
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Manganese
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc , R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Manganese Dioxide
Drakenfeld, B. F., & Co.
Foote Mineral Co.

Manganese (Oxide)
Ceramic Color & Chemical Mfg. Co.
Corhart Refractories Co.
Drakenfeld, B F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Masks (Breathing)
The DeVilbiss Co.
Drakenfeld, B. F., & Co.
Willson Products, Inc.

Metals (Porcelain Enameling)
American Rolling Mill Co.
Bethlehem Steel Co.

Microscopes (Polarizing)
Bausch & Lomb Optical Co.

Minerals
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Mixers
Ransome Concrete Machinery Co.

Mixers (Batch)
Lancaster Iron Works, Inc.

Mixers (Concrete, Paving, Road Paving, Plaster, Asphalt, Truck, Mortar, Bituminous)
Ransome Concrete Machinery Co.

Mold Sanders
Lancaster Iron Works, Inc.

Muffles (Furnace)
Allied Engineering Co.
Carborundum Co. (*Carbofrax*)
Chicago Vitreous Enamel Product Co.
Denver Fire Clay Co.
Electro Refractories & Alloys Corp.
Frazier-Simplex, Inc.
Norton Co.

Muffles (Laboratory)
Electro Refractories & Alloys Corp.

Mullite (Refractories)
Electro Refractories & Alloys Corp.

Muriatic Acid
Denver Fire Clay Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Pennsylvania Salt Mfg. Co.

Needle Antimony
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Nickel Salts
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Nitrates (Cobalt, Sodium)
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Nitre
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Non-Gro Refractories
Electro Refractories & Alloys Corp.

Norbide (Norton Boron Carbide)
Norton Co.

Olivine
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.

Opacifiers
Ceramic Color & Chemical Mfg. Co
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Metal & Thermit Corp.
The Porcelain Enamel & Mfg. Co.
The Vitro Mfg. Co.

Overglaze Colors
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co. Inc., R. & H. Chemicals Dept.

Oxides
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Metal & Thermit Corp.
Porcelain Enamel & Mfg. Co.
The Vitro Mfg. Co.

Palladium Decorations
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.

Pins
Chicago Vitreous Enamel Product Co.
The Hommel Co., O., Inc.
Louthan Mfg. Co.
Potters Supply Co.

Pins (Tile Setter)
Louthan Mfg. Co.

Placers (Concrete Pneumatic)
Ransome Concrete Machinery Co.

Platinum Decorations
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.

Polariscopes
Bausch & Lomb Optical Co.
Frazier-Simplex, Inc.

Porcelain Enameling Service (Practical)
American Rolling Mill Co.
Ceramic Color & Chemical Mfg. Co
Chicago Vitreous Enamel Product Co.
The Hommel Co., O., Inc.
The Porcelain Enamel & Mfg. Co.
The Vitro Mfg. Co.

Porcelain Enamels
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
The Porcelain Enamel & Mfg. Co.
The Vitro Mfg. Co.

Potters Wheels
Denver Fire Clay Co.

Potash (Carbonate)
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Solvay Sales Corp.
The Vitro Mfg. Co.

Producer Glass Plants
Frazier-Simplex, Inc.

Pug Mills
Lancaster Iron Works, Inc.

Pyrites (Natural Iron Sulphide)

Foote Mineral Co.
The Hommel Co., O., Inc.

Pyrometer Tubes
Carborundum Co.
Electro Refractories & Alloys Corp.

Pyrometer Tubes (Refractory and Hard Porcelain)
Denver Fire Clay Co.
McDanel Refractory Porcelain Co.
Norton Co.

Pyrometers (Optical, Radiation, Surface, Immersion, Needle)
Pyrometer Instrument Co.

Pyrometric Cones
The Edward Orton, Jr., Ceramic Foundation

Racks, Firing (Refractory)
Louthan Mfg. Co.

Raw Material Handling Equipment
Frazier-Simplex, Inc.
Lancaster Iron Works, Inc.

Refractometers
Bausch & Lomb Optical Co.

Refractories
Carborundum Co.
Corhart Refractories Co.
Denver Fire Clay Co.
Electro Refractories & Alloys Corp.
Louthan Mfg. Co.
Norton Co.

Refractory Materials
Carborundum Co.
Chicago Vitreous Enamel Product Co.
Corhart Refractories Co.
Denver Fire Clay Co.
Electro Refractories & Alloys Corp.
Louthan Mfg. Co.
Norton Co.

Represses (Automatic)
Lancaster Iron Works, Inc.

Respirators
Chicago Vitreous Enamel Product Co.
The DeVilbiss Co.
Drakenfeld, B. F., & Co.
The Hommel Co., O., Inc.
Willson Products, Inc.

Rutile
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Foote Mineral Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Metal & Thermit Corp.
The Vitro Mfg. Co.

Saggers
Carborundum Co.
Electro Refractories & Alloys Corp.
Norton Co.
Potters Supply Co.

Salt Cake
American Potash & Chemical Co.
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Pennsylvania Salt Mfg. Co.

Sandblast Helmets
Willson Products, Inc.

Sand Grinder and Sifters
Lancaster Iron Works, Inc.

Saponin
The Hommel Co., O., Inc.

Selenite of Sodium
Drakenfeld, B. F., & Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Selenium
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Setters (Tableware)
Louthan Mfg. Co.

Sheaves (Tower)
Ransome Concrete Machinery Co.

Sheets (Enameling Iron)
American Rolling Mill Co.
Bethlehem Steel Co.

Silica (Fused)
Electro Refractories & Alloys Corp.
The Hommel Co., O., Inc.

Silicate of Soda
Ceramic Color & Chemical Mfg. Co.
Denver Fire Clay Co.
The Hommel Co., O., Inc.
Harshaw Chemical Co.

Silicon Carbide
Carborundum Co.
Electro Refractories & Alloys Corp.
Norton Co.

Silicon Carbide Firesand
Carborundum Co.

Sillimanite Refractories
Denver Fire Clay Co.
Electro Refractories & Alloys Corp.

Slab Pushers—Hydraulic
Denison Engineering Co.

Slabs (Furnace)
Carborundum Co.
Electro Refractories & Alloys Corp.
Norton Co.

Soda Ash
American Potash and Chemical Corp.
Ceramic Color & Chemical Mfg. Co.
Denver Fire Clay Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Pennsylvania Salt Mfg. Co.
Solvay Sales Corp.
The Vitro Mfg. Co.

Sodium Antimonate
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Metal & Thermit Corp.
The Vitro Mfg. Co.

Sodium Fluoride
Ceramic Color & Chemical Mfg. Co.
Denver Fire Clay Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Sodium Metasilicate
Harshaw Chemical Co.

Sodium Nitrite
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Sodium Silica Fluoride
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Sodium Uranate
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Soot Blowers
Frazier-Simplex, Inc.

Special Machines
Frazier-Simplex, Inc.

Spar
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Paper Makers Importing Co.
The Vitro Mfg. Co.

Spray Booths
The DeVilbiss Co.
The Hommel Co., O., Inc.

Spraying Equipment
The DeVilbiss Co.
The Hommel Co., O., Inc.

Spurs
Louthan Mfg. Co.
Potters Supply Co.

Stacks
Lancaster Iron Works, Inc.

Steel Plate Construction
Bethlehem Steel Co.
Lancaster Iron Works, Inc.

Stilts
The Hommel Co., O., Inc.
Louthan Mfg. Co.
Potters Supply Co.

Sulfuric Acid
Denver Fire Clay Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Pennsylvania Salt Mfg. Co.

Talc
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Paper Makers Importing Co.

Tanks
Frazier-Simplex, Inc.

Tank Blocks
Corhart Refractories Co.

Tanks (Pickle)
Chicago Vitreous Enamel Product Co.
The Hommel Co., O., Inc.

Tanks for Raw Material Steel or Concrete
Bethlehem Steel Co.
Lancaster Iron Works, Inc.

Tile (Floor)
Norton Co.

Tile (Muffle)
Carborundum Co.
Electro Refractories & Alloys Corp.
Norton Co.

Tile Setter Pins
Louthan Mfg. Co.

Tile (Refractory)
Carborundum Co. (*Carbofrax*)
Chicago Vitreous Enamel Product Co.
Denver Fire Clay Co.
Electro Refractories & Alloys Corp.
Norton Co.

Tile (Wall)
Denver Fire Clay Co.

Tin Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
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PAPERS

AN ELECTRIC FURNACE FOR DETERMINATION OF PYROMETRIC CONE EQUIVALENTS*

By W. L. Pendergast

Abstract

The carbon-resistance furnace in use for a number of years at the National Bureau of Standards for making pyrometric cone equivalent determinations has undergone a number of improvements from the original. This paper describes the furnace in its present form and points out the changes.

I. Introduction

A number of years ago, a report by Pendergast[1] was published, giving a detailed description of an electric furnace used at the National Bureau of Standards for making softening point (now referred to as pyrometric cone equivalent) determinations. Since that time a number of changes in, and additions to, this apparatus have been made. These changes greatly facilitate making the tests and increase the precision with which they may be made. Because the Bureau has received numerous inquiries regarding the furnace, this article has been prepared to describe it in its present form and, incidentally, to point out the changes.

II. Furnace and Equipment

A general view of the furnace and accompanying equipment is shown in Fig. 1, and a working drawing showing the construction of the furnace is given in Fig. 2.

The shell of the furnace (Fig. 2, *E*), made of a fireclay body, is fired at approximately 1200°C before using. This shell formerly contained three lugs on which it was intended that the silicon-carbide ring was to rest. These lugs have been eliminated, and the silicon-carbide ring now rests directly on the granular graphite. The advantage of this arrangement is that the granular or flake graphite below the ring will remain fairly compact because it carries the weight of some of the furnace parts which are above it. The ends of the shell are closed with disks or covers also made of fire clay.

The silicon-carbide ring (Fig. 2, *N*) is made from a mixture of 95% either of No. 60 or No. 80 silicon carbide and 5% of Delaware (Newark) kaolin and is heated approximately to 1450°C before installing. A dilute solution of gum tragacanth is used as a temporary binding agent.

A mixture of the same composition as that from which the silicon-carbide rings are made is used as a seal between the upper outside edge of the silicon-carbide ring and the fireclay shell as indicated in Fig. 2. If this mixture is not available, then a stiff-mud mixture consisting of a very refractory ground fire clay and calcined fire clay or grog with water may be used. The purpose of this seal is to prevent graphite from falling into the space between the ring and the shell. Additional space between the shell and the silicon-carbide ring may be obtained by decreasing the diameter of the ring near its middle portion and tapering it gradually toward the ends so that the original diameter of the ends of the ring remain unchanged. This added space is an advantage when there is a tendency for the fireclay shell to fuse near this ring, owing to the high thermal conductivity of the silicon carbide.

The rings, which make up the muffle of the furnace and which at one time were made of electrically fused magnesite, are now made of electrically furnaced zirconium silicate or zirconium oxide. The zirconium oxide is considerably more expensive than the silicate, but the results obtained in a few tests made at the National Bureau of Standards indicate it to be preferable to the silicate.

Graphite electrodes have replaced the copper electrodes formerly used. The latter would occasionally melt and some of the molten copper would run from the opening in the bottom of the furnace and lodge on the gears of a rotating mechanism below the furnace. Because of oxidation, the graphite electrodes require more frequent replacement than the copper electrodes, but otherwise have proved to be much more satisfactory. The graphite electrode (Fig. 1) is made up of two parts, a ring within the furnace and an arm extending to the outside. This

* Received July 15, 1938.

[1] W. L. Pendergast, "Electric Furnace for Softening Point Determinations," *Jour. Amer. Ceram. Soc.*, **8** [5] 319–25 (1925).

arm is threaded into the ring. A simple tapered joint was tried, but because of the tendency of the arm to loosen, this method of joining the ring and arm was replaced by the threaded joint. The arms of the electrodes are sealed

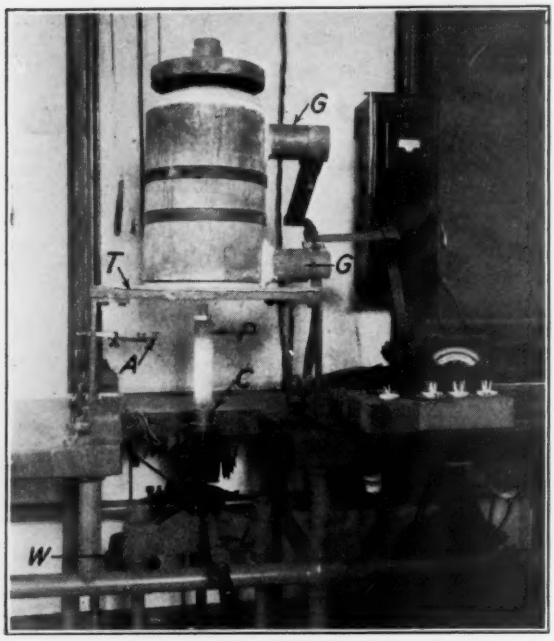

FIG. 1.—Furnace and equipment for making pyrometric cone equivalent determinations of refractory materials.

in the holes provided for them in the fireclay shell with a stiff-mud mixture of two parts alumina and one of kaolin.

The graphite used in the furnace, other than that from which the electrodes are made, is Ceylon flake. The material passes a U. S. standard No. 10 sieve and is retained on a No. 40 sieve to eliminate the fines.

An iron disk, weighing approximately 25 lb., is placed on top of the assembled furnace to reduce the shifting of the various parts during heating.

A sheet of asbestos is wrapped around the outside of the fireclay shell. It acts both as a heat insulator and as a cushion against strains between the sheet-iron casing and the fireclay shell.

The furnace rests on a small iron table (Fig. 1, *T*), the legs of which are equipped with thumb screws to permit leveling the furnace. The bottom ends of the screws ride in holes drilled in two bars of 1- by $^1/_2$-inch iron, which are permanently fastened to the laboratory bench and thereby prevent the table on which the furnace rests from shifting.

Figure 1 shows the part of the apparatus used for raising and lowering the refractory pedestal, *P*, on which the cone pat rests. By a vertical movement of the handle, *L*, the pedestal and driving mechanism may be quickly raised or lowered. A weight, *W*, acting through a chain and pulleys, counterbalances the pedestal and attachments. The pedestal rests in the cup, *C*, and is held tightly by set screws. Six such screws, in two horizontal rows $^1/_2$-inch apart, make for easier adjustment and clamping of the pedestal.

Careful alignment of the pedestal and furnace muffle is required because of the clearance of only $^1/_4$-inch between the periphery of the cone pat when sitting on the pedestal and the wall of the muffle. The adjustable arm (Fig. 1, *A*) is used for the alignment of the pedestal. The rate of rotation of the pedestal during its alignment and during operation of the furnace is controlled by the variable speed motor, *M*, one end of which is just barely visible in Fig. 1.

The clamp connecting the bus bar to the electrode was designed as shown because of the greatly different expan-

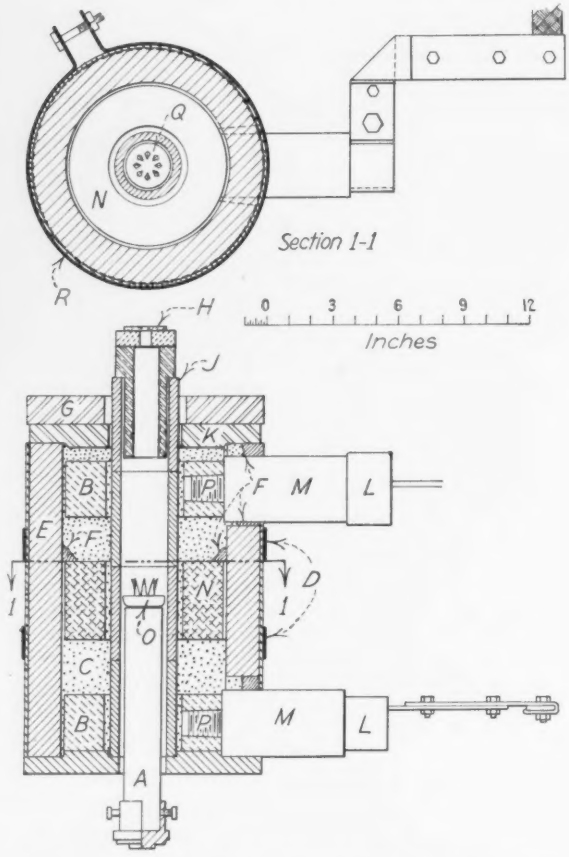

FIG. 2.—Drawing giving the details of construction of a carbon-resistance furnace for making pyrometric cone equivalent determinations of refractory materials. (*A*) high alumina refractory (cylinder, $1^3/_4$ by 10 in.); (*B*) graphite electrode ($2^1/_2$ in.); (*C*) graphite (granular flake); (*D*) iron bands; (*E*) fireclay shell; (*F*) fire clay; (*G*) iron disk; (*H*) microscope slide; (*J*) zirconium silicate or zirconium oxide; (*K*) refractory; (*L*) copper bus bar; (*M*) graphite; (*N*) silicon-carbide ring; (*O*) cone pat tapered about 10° on side, bottom edge rounded approximately $^1/_4$ in. radius; (*P*) 1-in. standard pipe thread; (*Q*) cones placed inside $^7/_8$-in. circle inclination of 8° from vertical; (*R*) sheet asbestos between shell and casing.

sion of the copper and graphite during heating. The bolt, set screw, and iron plates tend to distribute any strains present. A single bolt will tend to localize the strains at the bends and cause the copper band to tear at those places.

The electrical equipment for controlling the heating rate of the furnace consists of a 10-kw., 60-cycle, 220-volt primary; $47\frac{1}{2}$-volt secondary transformer; a ratio board; and an ammeter. The ratio board, on which are mounted seven double-throw single-pole switches, is tapped in between the transformer and the furnace. The secondary contains seven coils which deliver 16, 16, 8, 4, 2, 1, and $\frac{1}{2}$ volts, respectively. By means of the switches any one voltage or any combination of these voltages may be connected in series with the load, *i.e.*, any voltage between $\frac{1}{2}$ and $47\frac{1}{2}$ volts in increments of $\frac{1}{2}$ volt may be obtained with this arrangement. The ammeter with a capacity of 50 amperes is connected in the primary circuit to assist in regulating the temperature of the furnace.

III. Operation

Freedom from hot spots in the furnace muffle and favorable operating conditions may be obtained only by carefully packing the flake graphite so that a continuous and compact column is present between the two electrodes. It is especially important to pack the graphite properly between the silicon-carbide ring and the zircon or zirconium oxide muffle. For this purpose, a $\frac{1}{8}$-inch drill rod pointed at one end is used. It has been found that additional packing of the flake graphite around the outside of the muffle, after the furnace has reached a low red heat, is a great help in eliminating or reducing hot spots, decreasing current consumption, and attaining high temperatures.

A slow heating rate at the beginning of the furnace operation also appears to aid in obtaining uniform temperature throughout the hot zone. Satisfactory results are obtained by using between 5 and 10 amperes (as indicated by the ammeter in the primary circuit) for the first half hour of heating, up to 15 amperes the second half hour, and up to 20 the third half hour. On this basis, the temperature of the furnace reaches approximately 1000°C within two hours' time. The heating rate thereafter is such that the furnace reaches approximately 1500°C within 4 hours after starting, and subsequently the rate of 150°C per hour is used. The rate of 150°C per hour is in accordance with the standard test procedure for determining Pyrometric Cone Equivalent of Fire Clay and Fireclay Brick as outlined by the American Society for Testing Materials[2] and designated C24–35.

It is necessary to tighten the clamps on the electrodes as the furnace temperature rises, and it is desirable to loosen them after the tests have been completed and the current cut off.

When it is necessary to place pats in the hot furnace, as is the case when a series of tests is made, it is best to precalcine the cones and pats at about 1150°C. Such calcining prevents spitting of the test cones and cracking of the pats when they are placed in the heated furnace. The cones and pat are inserted slowly into the muffle (to reduce thermal shock) through the bottom of the furnace by means of the handle (Fig. 1, *L*).

During the test, the cone pat[3] is rotated at the rate of $2\frac{1}{2}$ to 3 turns per minute. Rotation of the pat tends to eliminate inaccuracies caused by uneven heating because, in spite of all precautions, hot spots occasionally develop in the walls of the furnace muffle.

The bending of the cones is observed through a peephole in the top cover of the furnace. If observations are difficult or uncertain, as is the case when the maximum temperature of the furnace is approached (approximately 1825°C), it may be necessary to lower the pedestal and cone pat for an instant to check an observation. The average time required for one heating cycle, in making successive tests of the same material or of a material having approximately the same pyrometric cone equivalent, is about 50 minutes. In making successive tests, the current is cut off after completing one test, and the furnace temperature drops approximately 150°C before the next pat is placed in the furnace.

National Bureau of Standards
Washington, D. C.

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[2] American Society for Testing Materials Book of Standards, Nonmetallic Materials [Part II]. pp. 229–32 (1936).

[3] To assist further in obtaining the proper end points of cones, a template is used when the cone pats are prepared. Both the correct distance of the cones above the pat and their angle of inclination are thereby assured.

STUDY OF SODA-ASH FOUNDRY-SLAG ATTACK ON THE REFRACTORY LINING OF A TEAPOT-TYPE, RESERVOIR LADLE*

By Paul S. Dear

Abstract

Siliceous fireclay ladle refractories in contact with soda-ash foundry slags are rapidly corroded and eroded, requiring frequent replacement. Chemical analyses, pyrometric cone equivalent tests, and petrographic studies of unused brick and of brick after a service campaign in contact with soda-ash foundry slag have been made. Microscopically, the used brick has been shown to consist of (1) a thin, inhomogeneous glass layer at the exposed surface of the brick, (2) a transition layer at the slag-brick interface, showing copious mullite development in a glass phase, (3) a greatly darkened vesicular layer immediately behind the transition layer, followed by (4) the main body of the brick, darkened but otherwise not greatly altered. A discussion of the mechanism of slag attack during the operation of the ladle is presented.

I. Introduction

Each year large tonnages of cast iron are refined with fused soda ash. The refining process is usually carried out in a teapot-reservoir ladle or in a stationary forehearth. The molten cast iron from the cupola (cupola slag removed) flows into the reservoir ladle, or forehearth, and is treated to the action of the soda ash before going to the casting floor in auxiliary pouring ladles.

In the ladle under study, the greatest deterioration of the refractory lining occurs on the back wall near the slag line. The temperature within the ladle is about 2600°F when soda ash is added. The resultant violent bubbling and splashing, turbulence, high temperature, and the concentration of alkali in the slag layer impose severe conditions on the refractory lining of the ladle. The life of the refractory lining is comparatively short, approximately 10 to 12 heats.

II. Object of the Investigation

Primarily, the object of this investigation was to study the nature of soda-ash foundry-slag attack on a reservoir ladle refractory lining after an average service campaign.

III. Literature Review

The Research Committee of the Refractories Division of the American Ceramic Society has suggested further study in the field of metallurgical slags.[1] The increasing use of alkali-containing slags in metallurgical practice makes a study of their action on refractory materials desirable.[2]

Because an excellent and inclusive bibliography on petrographic methods has been compiled,[3] specific references on the use of the polarizing microscope in refractories research and investigation will not be given here.

IV. Description, Chemical Analysis, and P.C.E. Test

(1) Original Brick

The dry-pressed fire brick tested were $2^1/_2$ by 4 by 8 inches, uniform in size and shape, with a rather impervious surface skin; the apparent porosity, determined from specimen cores, was 16.5%.

A core was re-fired at various temperatures between 1250°F and 2600°F. Beginning at 2200°F, pronounced swelling was evident, continuing in magnitude until at 2600°F there was a 120% increase in bulk volume over that of the original. The resultant structure was exceedingly vesicular and characteristic of a badly overfired brick.

Pyrometric cone equivalent tests of the brick showed softening to begin at 2600°F and to be complete at 2800°F. Within this temperature range, considerable swelling was again evident.

A chemical analysis of the original brick is given in Table I.

Table I

Chemical Analysis of Samples

	I (%)	II (%)	III (%)	IV (%)
SiO_2	61.9	62.9	57.1	40.1
Al_2O_3	29.1	30.6	25.2	5.9
Fe_2O_3	4.4	3.6	3.1	7.0
MnO	Nil	Nil	1.4	5.9
CaO	0.5	0.4	0.4	0.7
MgO	0.8	0.9	0.7	0.7
Na_2O	2.7	1.8	11.8	32.5
K_2O	1.8	1.2	1.9	2.4

(I) specimen from original brick.
(II) specimen from behind vesicular layer of used brick.
(III) specimen chipped from slag layer adhering to used brick
(IV) specimen from skimmed ladle slag.

Note: Slag adhering to brick contains small amounts of sulfide and sulfate sulfur.

Skimmed ladle slag contains an appreciable amount of sulfide sulfur, a small amount of sulfate sulfur, and some CO_2.

(2) Ladle Slag

In the foundry ladle of this study, a concentration of soda ash between 4 and 6 pounds per ton of molten metal flowing into the ladle was used. The slag layer was

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* Presented at the Fortieth Annual Meeting, American Ceramic Society, New Orleans, La., March 30, 1938 (Refractories Division). Received May 4, 1938.

[1] "Problems for Research on Refractories," *Bull. Amer. Ceram. Soc.*, **15** [1] 22–28 (1936).

[2] F. Hartmann, "Action of Alkalis on Refractory Brick," *Stahl u. Eisen*, **57**, 1017–22 (1937); *Ceram. Abs.*, **17** [5] 185 (1938).

[3] T. N. McVay, "Bibliography of Ceramic Microscopy," *Bull. Amer. Ceram. Soc.*, **16** [2] 33–64 (1937).

allowed to build up in the ladle, and on long heats, when thickening was evident, a portion of the spent slag was drained by tilting the ladle backward and pouring off over the top. Refined iron was drawn off from the bottom of the ladle by a teapot spout.

Pyrometric cone equivalent tests of a drained slag sample showed rather abrupt softening near 1700°F, and at 1800°F, a fluid pool formed and spread over the supporting plaque. The chemical analysis of a drained slag sample is given in Table I.

(3) Slagged Brick

The samples of slagged refractory were selected from the back wall of the lining within the area over which the slag layer moved during the ladle tilting and returning. This was the location of greatest intensity of slag attack.

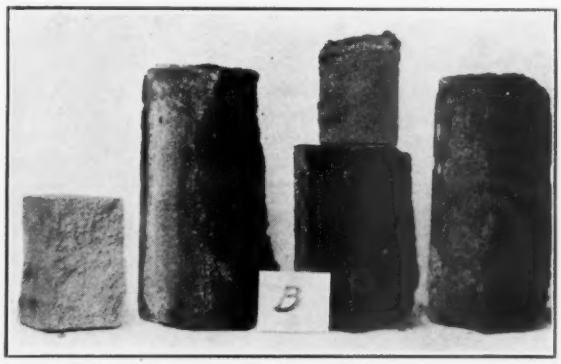

FIG. 1.—External appearance of ladle refractories after service in contact with soda-ash foundry slag. The sample on extreme left is a bat from an unused brick; the sample near the center was fractured to show the appearance of the used brick in cross-section. Note the thin glassy layer, grading through the vesicular layer to the main body of the brick.

Figure 1 shows (*a*) several slagged brick and (*b*) a portion of an unused brick. One of the slagged brick was fractured to show its cross-sectional appearance after a service campaign. The exposed face is coated with a thin glassy layer, and behind it is a layer with the characteristic vesicular structure obtained in the re-firing test. The main body of the used brick has changed from its original light color to a dark slate gray.

A specimen from behind the vesicular layer exhibited softening behavior similar to the specimen of the original brick, *i.e.*, it began to soften at 2600°F and completed softening at 2800°F. This dark slate-gray cone and the one prepared from the original brick were heated under identical oxidizing conditions in the P.C.E. test. Both cones were the same color at the end of the test, indicating that the slagged brick had probably been subject to reducing conditions in service.

NOTE: The term "reducing conditions," as used in this paper, refers to the effect on the brick of CO gas generated in the reactions taking place in the slag layer. The presence of CO is shown by the many jets of characteristic blue flame over the surface of the ladle slag during operation.

The chemical analysis of a specimen from behind the vesicular layer is given in Table I.

Particles of the adhering slag layer were carefully chipped away from the exposed brick face. It is estimated that the specimen so obtained contained about equal parts of the glassy layer and vesicular layer. In the P.C.E. test, this specimen began to soften at approximately 1850°F and completed softening at approximately 1900°F. The chemical analysis of this specimen is given in Table I.

V. Petrographic Studies

(1) Original Brick

Examinations of thin sections and fine particles of the original brick revealed a translucent, matted ground mass. Microscopically, mullite development was only feebly visible. A large amount of fine-grained free quartz was disseminated throughout the ground mass, only the very finest grains showing evidence of reaction rims. Many spots of a dark (red to opaque) iron-bearing material were present. An appreciable amount of glass (index between 1.53 and 1.54) was interstitial to the crystalline phases.

Specimens from the re-firing tests were examined. A great increase in amount of glass was apparent at 2200°F, and localized fluxing in the vicinity of iron oxide areas was quite noticeable.

It is inferred that the heat treatment of the original brick did not exceed 2200°F and was probably near 2100°F.

A photomicrograph of a thin section prepared from the original brick is shown in Fig. 2.

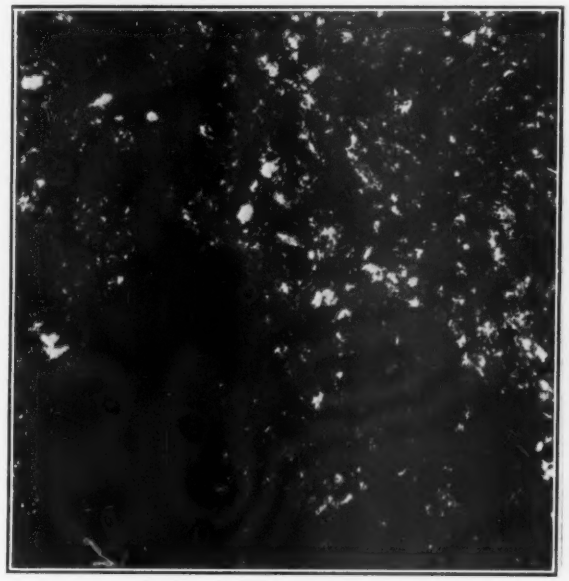

FIG. 2.—Section of the original brick with crossed Nicols; magnification 100×. A large amount of fine-grained quartz is seen disseminated throughout the fine-grained ground mass of minute mullite and glass phase. A large grain of iron-bearing material is visible in the lower part of the field.

(2) Slagged Brick

(*A*) *Outermost Glassy Portion of Slag Layer:* A photomicrograph of the outermost glassy part of the slag adhering to the brick is shown in Fig. 3. As the inhomogeneous

liquid drained downward over the brick face at the close of the campaign, cooling within the ladle was rapid enough to produce this relatively thin, inhomogeneous glass layer.

Traversing a section in a direction toward the body of the brick, the glass layer became appreciably darker in transmitted light. Just before reaching the slag-refractory interface, the section was almost completely opaque.

FIG. 3.—A vertical thin section through the glassy part of slag adhering to used brick, perpendicular to exposed face of brick; parallel Nicols; magnification 100×. The section shows the interesting "flow pattern" caused by liquid slag running down over the exposed face of the brick and cooling as an inhomogeneous glass. The body of the brick lies to right.

The transparent, extreme outermost layer of glass was 0.15 to 0.25 mm. wide; the over-all width of the inhomogeneous glass layer was approximately 4 to 5 mm.

Many minute particles of opaque materials were found in the vicinity of the slag-refractory interface. In places, these were portions of the refractory surrounded by glass; in other places, fairly well-developed cubic outlines of crystals (perhaps magnetite) were present.

The appearance of the glass layer and the high fluidity of the slag noted in the P.C.E. test indicate that corrosion was extremely severe at operating temperatures. Mechanical erosion was also pronounced each time the ladle was tilted and returned.

(*B*) *Slag-Refractory Interface:* Photomicrographs of the interface between slag and refractory are shown in Figs. 4 and 5.

A study of thin sections and powders from this zone shows well-developed interlocking mullite needles as the persistent solid phase crystallizing from the liquid in contact with the refractory. Many detached areas of refractory are suspended in the glass, acting as nuclei for the crystallization and growth of mullite. Only the largest quartz grains from the original brick appear to have resisted solution; these are characterized by (*a*) pronounced reaction rims and (*b*) noticeable inversion to cristobalite. The glass phase is present in large quantity, with a refractive index slightly less than the glass of the original brick.

The body of the refractory at the interface is much darker than the original, indicating (*a*) possible iron oxide absorption and (*b*) possible influence of CO gas from reactions in the slag layer.

(*C*) *Vesicular Layer:* The vesicular layer, immediately behind the slag-refractory interface, is characterized by great opaqueness in thin section and by the presence of many voids and pore spaces. With the exception of the noticeable darkening, this zone resembles the specimen core of the original brick after re-firing to 2600 °F.

Examinations of the thin section through this zone, in conjunction with particles carefully chipped from the zone, reveal much minute mullite. The glass phase is present in considerable amount. Segregated patches of well-developed mullite needles occur in the vicinity of some of the voids and pore spaces where more intense localized penetration of slag liquid has occurred. The quartz grains show unmistakable evidence of reaction and inversion, and very few of the smaller particles remain.

Fig. 4.—A vertical thin section through the brick-slag interface, perpendicular to the exposed face of the brick; parallel Nicols; magnification 100×. Passing from right to left, the section shows (1) the "flow pattern" caused by movement of slag over the exposed face of the brick, (2) penetration and corrosion of the refractory, with precipitation of mullite needles near the interface, (3) vesicular character of the layer immediately behind the brick-slag interface, and (4) darkening of the body of the brick.

(*D*) *Body of Refractory Immediately behind Vesicular Layer:* A photomicrograph of the slagged brick immediately behind the vesicular layer is shown in Fig. 6.

Appreciable mullite development occurs only in those areas where slag penetration or localized liquid formation has taken place. Quartz grains are more abundant, although evidence of reaction at their periphery is noticeable. Glass is present in considerable amount, though not

nearly in such great quantity as in the vesicular layer and at the interface. The body of the brick in this zone appears equally as dark in section as noted for the vesicular layer.

(*E*) *Main Body of Refractory Quite Far Removed from Slag Layer:* Some localized fluxing in the vicinity of iron spots is evident. Mullite is noticeably developed only where such localized fluxing occurred. Reaction rims on the quartz grains are barely discernible.

VI. Discussion

In teapot-type reservoir ladles using soda ash as a purifying agent, the intense attack on the refractory lining arose from a combination of severe chemical corrosion and pronounced mechanical erosion.

The liquid slag has high basicity and is very fluid at operating temperatures. Further addition of soda ash is accompanied by violent bubbling, splashing, and turbulence, greatly augmenting solution of the refractory and penetration by liquid slag.

All of the reactions between soda ash and molten metal are not definitely known, but liberal quantities of CO gas are known to be evolved at the slag line. The presence of

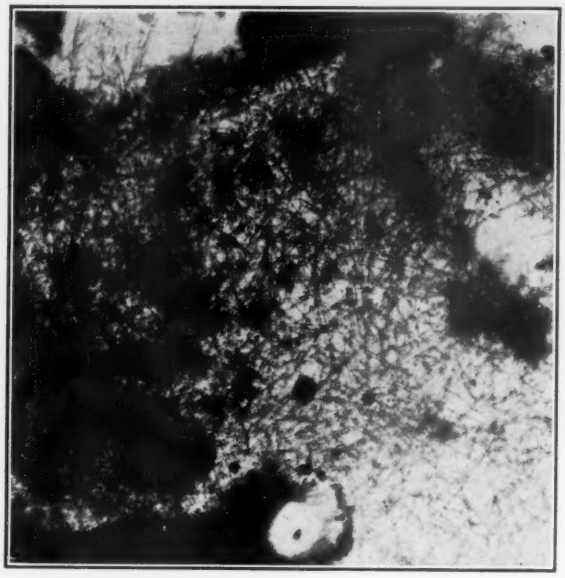

FIG. 5.—Vertical thin section parallel to the exposed face of the brick, very close to the brick-slag interface; parallel Nicols; magnification 100×. The section shows (1) the penetration of and corrosion by slag, (2) portions of the brick detached from its main body and suspended in the slag where they act as nuclei for the precipitation and crystallization of (3) well-developed, interlocking needles of mullite.

CO gas perhaps partially explains the darkening of the brick at the interface and in the vesicular layer behind, because the CO would act as a reducing agent toward the iron compounds in the brick.

The glass, the cristobalite, and the other forms of silica in the brick were taken in solution first, followed by the finely divided mullite and clay body. The presence of well-crystallized mullite needles as the persistent solid phase at the slag-refractory interface indicated that the liquid at the contact surface was enriched with alumina.

The condition throughout the contact area is somewhat as follows: (*a*) a very fluid, highly basic liquid grading back through (*b*), a liquid of increased viscosity in which

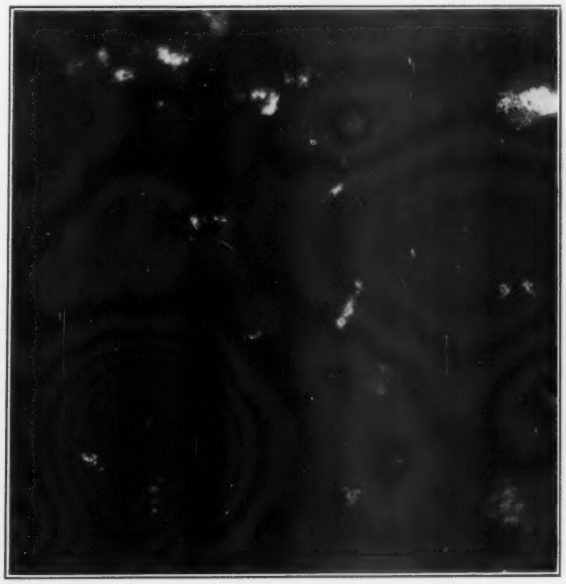

FIG. 6.—Thin section of used refractory immediately behind the vesicular layer; parallel Nicols; magnification 100×. Note the great increase in opacity as compared to the ground mass of the original brick.

the content of iron and manganese oxides and alumina appears to be greater, to (*c*), a liquid of relatively high viscosity at the interface, caused by solution of refractory enriching the alumina and silica content to the point where abundant mullite crystallization takes place. Immediately behind this viscous layer is the vesicular layer of the refractory where more or less localized penetration and fluxing occurs. This is pictured as the "condition gradient" before each tilting of the ladle.

When the ladle is tilted, the very fluid, highly reactive liquid slag moves down the back wall and up the front wall. Mechanical erosion is then effective. The flow of fluid slag washes away the dissolved and corroded material, exposing fresh areas of refractory for subsequent attack. Pouring completed, the ladle is returned to the normal position. The reactive slag, reversing its travel, moves up the back wall and down the front wall, washing the freshly exposed areas and bringing up less saturated slag liquid to renew the interfacial corrosion.

Penetration of slag liquid does not appear to be appreciable with these brick. Reaction at the interface is limited to a comparatively narrow zone. It is entirely possible that the highly aluminous glass phase at the refractory face is so viscous that diffusion of slag liquid into it and through it is slow,[4] thereby inhibiting deep-seated reaction

[4] G. W. Morey, "Glassy Phase in the Manufacture and Use of Refractories," *Bull. Amer. Ceram. Soc.*, **14** [6] 202–206 (1935).

and confining corrosion to a narrow zone. During each ladle pour and return, it is this thin layer of corroded refractory that is carried away with the fluid slag.

It is apparent that under the existing operating conditions thermodynamic equilibrium at the slag-refractory interface can hardly be possible with the type of refractory and slag involved here. Fundamentally, a siliceous fireclay refractory is not sound for resistance to such basic slag conditions.

The persistence of mullite as solid phase at the slag-refractory interface suggests that a refractory of higher mullite content than that of the siliceous fireclay brick should be a more effective barrier to corrosion because of an appreciable reduction in rate of solution at the contact surface. Testing a number of different refractories in contact with the soda-ash foundry slag, Haff[5] found increased corrosion resistance as the alumina content (or mullite content) of the alumina-silica series was increased.

VII. Summary

A study of a used and unused siliceous fireclay brick from a foundry ladle, using soda ash as a purifier, emphasizes the fact that rapid deterioration of the ladle lining is caused by a combination of (1) intense chemical corrosion by the basic liquid slag and (2) severe mechanical erosion by tilting and returning the ladle during operation. Splashing, bubbling, and turbulence accompanying soda-ash additions augment the rate of solution and erosion.

The fluid, highly alkaline slag grades back through a liquid of increased viscosity near the lining face to a liquid of relatively high viscosity at the lining face. The latter liquid results from the enrichment of the alumina and silica content by the refractory solution to the point of mullite saturation. Immediately behind the slag-refractory interface is a vesicular layer of brick, ripe for subsequent attack. The relatively highly viscous liquid at the refractory face acts as a temporary barrier to deep-seated corrosion and penetration.

Siliceous fireclay brick are fundamentally wrong in contact with basic soda-ash foundry slag. Persistence and re-crystallization of mullite in the slag-refractory contact area suggest brick of higher alumina content as a more effective corrosion barrier against the soda-ash slag. Another study[5] has shown this to be the case.

Acknowledgments

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[5] R. S. Haff, "Corrosion of Refractories by Soda-Ash Foundry Slag." Thesis submitted in partial fulfillment of requirements for the M.S. degree in Ceramic Engineering, Virginia Polytechnic Institute, June, 1938.

CERAMIC USES OF VOLCANIC ASH*

By Norman Plummer

Abstract

Volcanic ash has been successfully used in several types of glazes, replacing the feldspar and a portion of the flint and constituting in some glazes more than 50% of the total weight of the raw materials. Both fritted and raw glazes were used for the tests, and the maturing temperatures ranged from cones 09 to 8. Incomplete investigations indicate that volcanic ash should prove equally successful in enamels and glass batches. In general, colorless glazes or glass can not be obtained because of the high iron content.

I. Introduction

The use of volcanic ash as a ceramic raw material has not been extensive, although the practicability of its use has been indicated both by laboratory and industrial application.[1]

The object of the present investigation was to determine the effect of the use of volcanic ash in glazes by comparison with glazes of nearly identical composition except that they contained feldspar or equivalent materials.

II. Characteristics of Volcanic Ash

Two representative samples from widely separated localities were used: No. 1 from McPherson County, Kansas, and No. 2 from near Gate in the Oklahoma Panhandle. The chemical analyses[2] and formulas are as follows:

	Sample No. 1 (%)	Sample No. 2 (%)
Ignition loss	4.68	4.18
Na_2O	4.00	4.50
K_2O	2.00	2.26
CaO, MgO	0.99	0.91
Al_2O_3	13.62	14.46
Fe_2O_3	2.33	1.44
SiO_2	72.30	71.90

* Presented at the Fortieth Annual Meeting, American Ceramic Society, New Orleans, La., March 29, 1938 (Materials and Equipment Division). Received May 3, 1938.

[1] (*a*) C. L. Baker, "Volcanic Ash in Texas," *Bur. of Econ. Geology, Univ. of Texas, Mineral Resources Circ.*, No. 2, December, 1931.

(*b*) F. W. Preston, "Volcanic Ash as a Constituent of Glass Batches," *Glass Ind.*, **16** [4] 111 (1935); *Ceram. Abs.*, **14** [6] 138 (1935).

[2] Chemical analysis of No. 1 by Department of Chemistry, Univ. of Kansas, Lawrence, Kansas; chemical analysis of No. 2 furnished by the Mid-Co Products Co., Kansas City, Mo.

Formula No. 1

Na_2O	0.610				
K_2O	0.201	Al_2O_3	1.265	SiO_2	11.384
CaO, MgO	0.189	Fe_2O_3	0.138		

Combining equivalent weight, 945.

Formula No. 2

N_2O	0.637				
K_2O	0.211	Al_2O_3	1.244	SiO_2	10.520
CaO, MgO	0.152	Fe_2O_3	0.079		

Combining equivalent weight, 875.

The potash content is relatively higher in published analyses of other samples.[1(a)]

The pyrometric cone equivalent of both samples was 4 to 5. At cone 7, the material fused to a clear greenish-gray glass. At the deformation temperature, the material was translucent and free from blebs or bubbles.

III. Testing Procedure

The volcanic ash was used to replace feldspar and a portion of the silica in several glazes.

The glazes were applied by spraying on tile stamped out with a $2^5/_8$-in. die from a cream-firing ball-clay body and on small vases approximately $2^1/_2$ in. high. The tile and vases were biscuited at cone 2. Cones 09 to 04 glazes were fired in a gas-fired kiln with an 18- by 24- by 30-in. muffle. Higher temperature glazes were fired in a smaller gas-fired muffle kiln at approximately the same rate of heating as used in the larger test kiln.

IV. Glaze Tests

(1) Frits Used

Frit A (24.2% volcanic ash)

Volcanic ash No. 1	75.25
Red lead	208.85
Flint	27.36

A cone 08 to 06 glaze was prepared with the following composition:

Glaze No. A-1

Lead frit A	303.00
Florida kaolin	23.27
Flint	2.30

Formula

PbO	0.920				
Na_2O	0.049				
K_2O	0.016	Al_2O_3	0.192	SiO_2	1.592
CaO, MgO	0.015	Fe_2O_3	0.012		

(2) Glazes with Frit A

Lead glaze A-1 is a bright glaze maturing from cones 08 to 06 and is similar to a commercial lead glaze now in use. When applied to an ivory-colored bisque, little difference in color could be detected either in A-1 or in the control glaze. The firing behavior was identical.

In colored glazes, differences in tint were even less evident.

The four transparent colored glazes prepared for the test contained the following ingredients: A-2 (brilliant yellow-orange with red specks), sodium uranate 7%; A-3 (dark cherry-red), ferric oxide 9%; A-4 (thin brown), manganese carbonate 4%; and A-5 (thin blue), cobalt carbonate 2%.

Frit B (lead-borax): 32.68% volcanic ash

Batch

Red lead	140.45
Volcanic ash No. 2	104.47
Borax	60.31
Potassium carbonate	14.75

Frit C (borax): 55.5% volcanic ash

Batch

Volcanic ash No. 2	184.80
Borax	86.49
Soda ash	30.56
Potassium carbonate	13.80
Whiting	17.43

(3) Glazes with Frit B

Glaze No. B-1 (cones 08 to 05)

Batch

Frit B	233.86
Volcanic ash No. 2	58.89
Bentonite	13.91
Flint	15.96
Manganese carbonate	10.47

Formula

PbO	0.515				
Na_2O	0.241				
K_2O	0.123	Al_2O_3	0.232	SiO_2	2.119
CaO, MgO	0.026	Fe_2O_3	0.013	B_2O_3	0.265
BaO	0.011				
MnO	0.091				

This is a bright warm brown glaze maturing at cone 08 and rather thin at cone 05. The color was richer in the volcanic-ash glaze than in the control glaze.

Glaze No. B-3 (cones 07 to 06)

Batch

Frit B	55.85
Volcanic ash No. 2	87.50
Lead carbonate	114.26
Whiting	9.90
Barium carbonate	20.29
Cobalt oxide	4.20
Florida kaolin	10.58
Flint	7.74

Formula

PbO	0.565				
Na_2O	0.111				
K_2O	0.047	Al_2O_3	0.195	SiO_2	1.514
CaO	0.118	Fe_2O_3	0.010	B_2O_3	0.063
BaO	0.103				
CoO	0.056				

This is a smooth dark-blue mat glaze at cones 07 to 06 with a short firing range. It is slightly glossy at cone 05 and underfired at cone 08. The color was not noticeably affected by the use of volcanic ash.

Glaze No. B-4 (cones 06 to 1)

Batch

Frit B	139.63
Volcanic ash No. 2	56.00
Whiting	13.79
Zinc oxide	11.40
Lead carbonate	5.91
Copper oxide	8.64
Tin oxide	40.66
Bentonite	5.17

Formula

PbO	0.357				
Na_2O	0.160				
K_2O	0.078	Al_2O_3	0.154	SiO_2	1.354
CaO, MgO	0.166	Fe_2O_3	0.010	SnO_2	0.156
ZnO	0.140			B_2O_3	0.158
CuO	0.109				

The control glaze containing feldspar produced a brilliant turquoise at cones 06 and 1, but in this glaze containing volcanic ash the blue color was neutralized by the iron and a bright green resulted. The excellent covering power and long firing range of the glaze were not changed by the use of volcanic ash.

(4) Glazes with Frit C

Glaze No. C-1 (cones 06 to 1)

Batch

Frit C	143.00
Volcanic ash No. 2	56.00
Whiting	12.60
Zinc oxide	4.07
Lead carbonate	28.55
Copper oxide	8.76
Bentonite	2.97
Tin oxide	41.68

Formula

PbO	0.100				
Na_2O	0.398				
K_2O	0.093	Al_2O_3	0.229	SiO_2	1.925
CaO	0.243	Fe_2O_3	0.014	SnO_2	0.160
ZnO	0.050			B_2O_3	0.249
MgO	0.006				
CuO	0.110				

This glaze is mature at cone 06 and not overfired at cone 1. The color is a brilliant turquoise both in the control glaze and in the glaze containing volcanic ash. Covering power and firing range were not affected within the limits tested. The effect of the iron on the color is noticeable by a slight yellowing at the higher temperature.

Glaze No. C-2 (cones 06 to 04)

Batch

Frit C	45.50
Volcanic ash No. 2	52.50
Red lead	98.66
Whiting	12.45
Zinc oxide	6.67
Barium carbonate	10.01
Copper carbonate	9.40
Cobalt carbonate	3.94
Flint	13.03
Tin oxide	28.81

Formula

PbO	0.432				
K_2O	0.038				
Na_2O	0.152				
CaO, MgO	0.170	Al_2O_3	0.121	SiO_2	1.237
ZnO	0.082	Fe_2O_3	0.008	SnO_2	0.111
BaO	0.051			B_2O_3	0.079
CuO	0.042				
CoO	0.033				

A more brilliant gloss and a smoother texture were produced by the use of volcanic ash than in a feldspar glaze with the same formulas. The color was grayish blue in both, tending to be more neutral when volcanic ash was used.

Glaze No. C-3 (cones 06 to 05)

Batch

Frit C	42.38
Volcanic ash No. 2	43.75
Lead carbonate	107.53
Whiting	4.90
Zinc oxide	17.91
Barium carbonate	9.06
Copper oxide	4.46
Chromium oxide	2.28
Bentonite	11.29
Flint	6.00

Formula

PbO	0.416				
Na_2O	0.138				
K_2O	0.034				
CaO	0.090	Al_2O_3	0.124	SiO_2	1.152
ZnO	0.220	Cr_2O_3	0.015	B_2O_3	0.074
BaO	0.046				
CaO	0.056				

The control glaze for No. C-3 was a dark mottled green. With volcanic ash the color was duller, and the glaze was somewhat thinner on sharp edges.

Glaze No. C-4 (cones 4 to 6)

Batch

Volcanic ash No. 2	159.50
Frit C	31.72
Whiting	49.80
Lead carbonate	51.70
Florida kaolin	18.06
Flint	33.30

Formula

CaO	0.550				
Na_2O	0.194	Al_2O_3	0.326	SiO_2	2.86
K_2O	0.056	Fe_2O_3	0.016	B_2O_3	0.055
PbO	0.200				

The empirical formula for this glaze is approximately the same as that of a commercial whiteware glaze. When fired on a whiteware tile or on a soft paste vitrified porcelain body, the color is similar to the light ivory commonly used on dinnerware. The color of a slightly grayed stoneware body was improved under this glaze. The firing properties were satisfactory. Volcanic ash comprises 51% by weight of raw materials in this glaze.

Glaze No. C-5 (cones 09 to 06)

Batch

Volcanic ash No. 2	56.00
Frit C	143.00
Whiting	12.60
Lead carbonate	28.55
Zinc oxide	4.07
Bentonite	2.97

Formula

PbO	0.112				
Na_2O	0.447				
K_2O	0.105	Al_2O_3	0.257	SiO_2	2.163
CaO	0.273	Fe_2O_3	0.016	B_2O_3	0.280
MgO	0.007				
ZnO	0.056				

No trace of color could be detected in this glaze when fired on a white wall-tile body, and in this respect it was unique among the glazes tested. At cone 06, the glaze was thin and crazed on a well-vitrified body. The control glaze was identical in appearance to that containing volcanic ash.

(5) Raw Lead Mat Glazes

Glaze No. BM-0 (cones 07 to 05)

Batch	
Volcanic ash No. 1	68.18
Lead carbonate	130.03
Whiting	18.40
Zinc oxide	19.62
Florida kaolin	20.12
Flint	1.44
Tin oxide	12.99
Titanium oxide	16.24

Formula

PbO	0.503		
Na_2O	0.044	Al_2O_3 0.169	SiO_2 1.000
K_2O	0.015	Fe_2O_3 0.010	SnO_2 0.086
CaO	0.197		TiO_2 0.203
ZnO	0.241		

An excellent smooth-textured mat was produced with this glaze. The color was a rich cream. The control glaze containing no ash was a light ivory, but otherwise it was identical.

This glaze was used as a base in the following colored glazes:

No. BM-1: BM-0 (base glaze) 100.0 and cobalt carbonate 0.5. The control glaze containing no volcanic ash was a gray-blue; No. 1 was a gray-tan (the color variation from the volcanic ash was greater in this glaze than in any other).

No. BM-2: BM-0 (base glaze) 100.00, sodium uranate 2.38, and ferric oxide 2.38.

No. BM-3: BM-0 (base glaze) 100.00 and sodium uranate 2.26. BM-2 was a yellow-brown and BM-3, a yellow-cream both in the controls and the volcanic ash glazes; little difference in color was noted.

No. BM-4: BM-0 (base glaze) 100.00 and copper carbonate 2.26. A light yellow-green was produced in this glaze; the color difference in the control and the volcanic-ash glaze was slight. This series of glazes has been used effectively on ceramic sculpture, and the volcanic-ash glazes have proved superior to the control glazes in uniformity of texture on irregular surfaces.

Cone 09 Glaze

Batch	
Lead carbonate	217.14
Volcanic ash No. 2	52.50
Copper oxide	7.96
Florida kaolin	7.74
Flint	53.04
Rutile	22.80

Formula

PbO	0.840		
Na_2O	0.038		
K_2O	0.013	Al_2O_3 0.102	SiO_2 1.575
CaO	0.009		TiO_2 0.285
CuO	0.100		

The control glaze from which this formula was adapted to a volcanic ash recipe is a commercial pottery glaze. The mottled green color and texture of the glaze were little affected by the use of the ash.

(6) Other Glazes

(*a*) A cone 6 to cone 7 Bristol glaze was fired on a stoneware body. The texture and opacity were satisfactory. The color was faintly yellow, but no more so than many commercially used stoneware glazes.

Batch	
Volcanic ash No. 2	206.50
Whiting	36.40
Zinc oxide	32.56
Florida kaolin	68.63
Flint	17.10

Formula

CaO	0.40		
Na_2O	0.15	Al_2O_3 0.55	SiO_2 3.30
K_2O	0.05		
ZnO	0.40		

It will be noted that more than 57% of the raw materials in this glaze is volcanic ash.

(*b*) A glaze composed of 95% No. 2 volcanic ash and 5% ferric oxide was fired to cone 5 on an earthenware body, producing a mature dark red-brown mat glaze with a fine-grained texture. This same glaze was a darker brown gloss at cone 8.

(7) Other Ceramic Uses for Volcanic Ash

(*a*) *Cast-Iron Enamel:* An excellent ivory enamel was produced by a nationally known manufacturer of sanitary ware, using volcanic ash as a substitute for feldspar in the formula. No exact data are available.

(*b*) *Glass Batch:* A glass batch corresponding in composition to that used by a bottle manufacturer was prepared in the laboratory.

Batch	Parts by weight
Sand	1200.0
Volcanic ash No. 1	100.0
Soda ash	545.5
Raw limestone	95.4

There was no difficulty in melting this glass. Although no tests were made on the glass other than handling on a rod and spinning a thread, it apparently does not differ from the commercial feldspar-containing glass except for the slight blue-green discoloration from the iron, which would be of no importance in manufacturing green and brown bottles.

V. Summary and Conclusions

Twenty-two glazes containing volcanic ash up to 57% of the total weight of the raw ingredients were compared to an equal number which contained no volcanic ash but were nearly identical in chemical composition. No significant difference was noted in the volcanic ash glazes and the control glazes, other than the coloring effect of the iron oxide in the ash. This coloring effect was quite varied in intensity. A whiteware glaze and a tin enamel were changed from white to ivory or light cream, while one transparent bright glaze (C-5) showed no yellow color on a white wall-tile body.

The use of volcanic ash to replace the feldspar in glazes and glass batches seems to offer a distinct advantage from the standpoint of economy, considering the low cost of the material (about $2.00 a ton f.o.b.) and the finely divided condition of the ash in its natural state. These advantages should be of especial importance in colored glazes for roofing tile, wall tile, and low-priced pottery. In general, the slight neutralization of the colors results in more pleasing effects on artware and ceramic sculpture.

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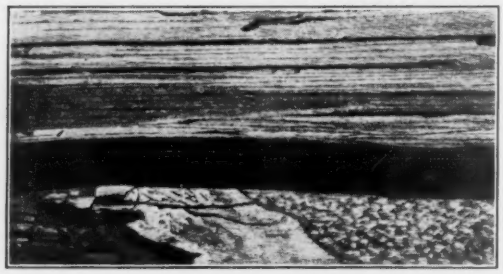
THE TERM "STRIATION" AND CERTAIN OTHER TERMS USED IN GLASS TECHNOLOGY*

By F. W. Preston

The orthodox meaning of a word is given by the dictionary, but the dictionary finds out what the orthodox meaning is by reference to its usage in the hands of authors. Some words, in their technical significance, are used very seldom; sometimes the author assumes that the reader knows what is meant and this is not always a good assumption. At other times, the author assumes the word has only one meaning when as a matter of fact it has two or more, and quite different, meanings.

One such term is "striation" as applied to glass technology. The term was not invented by glass technologists or even by scientists. It is an old word, having a general usage. It carries with it a notion of a thing "striped," especially one striped with faint grooves or ridges. Thus, in a sense, the surface of the sea is "striated" by its waves which extend in long parallel swells and depressions; but the term is probably never used that way.



Figs. 1(*a*) and 1(*b*).—"Striations" according to the geologist (after Chamberlin). These are superficial scratches. The same phenomenon on abraded metal is called "striation" by Ellefson and Taylor.

Fig. 1(*a*) shows horizontal striation on a vertical face overlooking Lake Cayuga, about a mile north of Ithaca, N. Y. The dark groove near the base retires eight inches from the face and is striated on top, bottom, and back.

The seashore, if sandy, is often "striated" with little ridges of sand, but Coleridge preferred to speak of them as ribbings. The geologists have referred to the rock-scorings of the great ice invasions as "striations" or "striated surfaces."[1] Here the striations are a result of the dragging of loose rock fragments, by the ice, over fixed rock surfaces. Chamberlin uses the terms "striae" and "striations" interchangeably, so that, in the geological field, a "stria" is a surface marking in no way inherent in the original structure of the rock. It is a product of the subsequent maltreatment of the rock (see Figs. 1(*a*) and 1(*b*)).

In the field of crystallography or mineralogy, we again meet with the term "striations" to mean a different phenomenon. Certain crystals have a habit of growing with some of the faces marked with parallel lines in the nature of fine ridges, grooves, or steps. This is the case with common rock-crystal (quartz), which is the backbone of the glass industry (see Fig. 2).

Thus Dana writes of quartz,[2] "Crystals commonly prismatic, with prism faces horizontally *striated*." And again, "Crystals at times very much distorted, when the recognition of the prism faces by their horizontal *striations* will assist in the orientation of the crystal."

The italics are ours. The words "striated" and "striation" do not occur in the index of the book.

I have not attempted to trace the words to earlier editions, for the terms are perfectly well known and accepted in this field. To the best of my knowledge, they are always referred to as striations and not as striae. The striations are a natural feature of the crystal, not a product of abrasion or after-treatment. They do not represent any imperfection or change in composition of the crystal.

Fig. 1(*b*).—Descending striae on a vertical face, on a cliff overlooking Lake Cayuga (photographs by H. S. Williams).

In the field of metallurgy, the term "striation" is used in the vernacular, but apparently the textbooks for the most part prefer "banded structure." In the rolling of steel ingots to bars and sheets, nonmetallic inclusions are rolled to a string or platelike form. The resulting laminated structure is referred to as "banded," and the inclusions become "striations."[3]

It will be obvious that the physical nature of these "striations" is entirely different from either the geological or the mineralogical varieties. In the metallurgical field, the striations are inhomogeneities in the body of the steel,

* Received September 16, 1938.

[1] T. C. Chamberlin, Seventh Annual Report of the U. S. Geological Survey, 1855–86, 155 pp., *et seq.*

[2] Dana's Manual of Mineralogy (William E. Ford) 14th ed., 1929. John Wiley & Sons, Inc., N. Y.; Chapman & Hall, Ltd., London. Similar remarks are found in Dana's Textbook of Mineralogy.

[3] Information from R. B. Dimmick, American Rolling Mills, and also Nelson W. Taylor, State College, Pa.; see also Figs. 3(*a*) and 3(*b*).

contemporaneous with the steel and elongated by the fabricating process.

Ellefson and Taylor,[4] however, use the term "striation" as applied to metals in a different sense. They describe how they prepared a specimen of gold as a platform to support a piece of glass during an experiment and state that "after polishing, no striations could be observed under a magnification of 450." In a private letter to the writer, Dr. Taylor writes, "My use of 'striations' was in the sense of nearly parallel scratch marks on the metal due to polishing material."

FIG. 2.—"Striations" according to the mineralogist. A quartz crystal horizontally "striated" on the prism faces (Lac Remy, Quebec). The "striations" here are a natural feature of the crystal's growth.

Here we have glass technologists, when referring to the metallurgical field, using the term in the geologist's sense. The workshop term for the phenomenon sought by Taylor (in optical glass and plate glass factories) would be "sleeks," but the term would convey little or nothing to bottle makers or ceramists.

When a glass surface is made by fracturing, the fracture surface shows, in general, two sorts of markings, orthogonal to one another. One of these is a wave-front

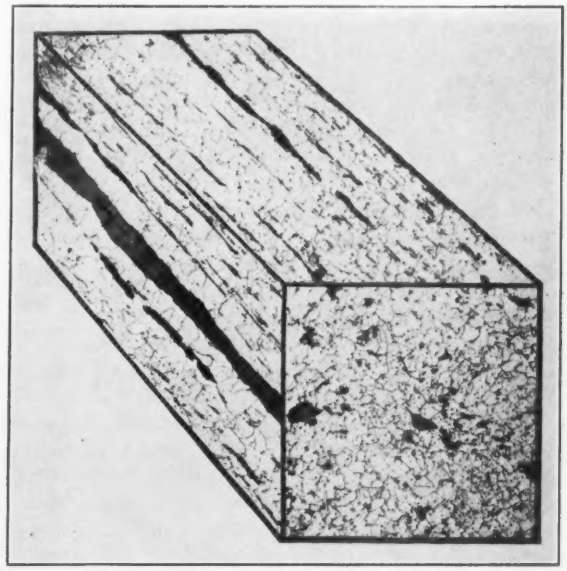


FIG. 3(*a*).—"Striations" according to the metallurgist. Wrought iron with slag inclusions, elongated by "working" the metal. After Albert Sauveur, Metallography and Heat Treatment of Iron and Steel. McGraw-Hill, 1935 (picture supplied by N. W. Taylor).

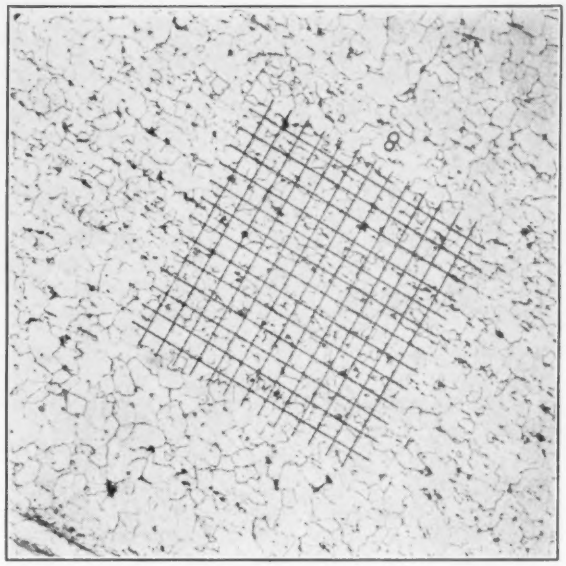


FIG. 3(*b*).—Slag inclusions in Armco iron ×100 (supplied by S. J. MacMullan, Jr.). Both Mr. MacMullan and Mr. Dimmick insist that the term "striations," as applied to this phenomenon, is very rare, both in the literature and in the plants.

mark, and the other is what de Fréminville[5] called a "strie." Now "strie" is merely the French version of the

[4] B. S. Ellefson and N. W. Taylor, "Surface Properties of Fused Salts and Glass: II," *Jour. Amer. Ceram. Soc.*, **21** [6] 205–13 (1938); p. 208.

[5] C. de Fréminville, "Recherches sur la Fragilité," *Rev. mét.*, **11**, 971 (1914).

Latin "stria"; de Fréminville's "stries" are not made by ice or by any subsequent treatment of the glass surface. They are made in the very process of making the surface and are an integral part of it. They do not exist prior to the surface formation and form no part of the original glass structure; nor do they originate, like Chamberlin's, subsequently. They are contemporaneous and simultaneous with the formation of the surface. Their exact genesis is described by the writer.[6] In that paper, the French term "strie" is rendered by the English "striation" or "striated surface."

Scholes[7] uses the term "striations" as synonymous with "inhomogeneity of the glass," and it is therefore neither a geological "striation" nor a surface striation; it is neither a Chamberlin nor a Preston striation. Scholes uses it as synonymous with "striae" as used by Wright.[8]

The use of the term "striae" in English textbooks on optical glass goes back many years, and I have made no search for its origin. Thus it is used by Rosenhain[9] a score of times, sometimes in quotation marks and sometimes without, and in all cases it refers to a lack of homogeneity in the original glass. Methods of testing for "striae," not polariscopic, are given, but Rosenhain never uses the term "striation." The English equivalent that he gives is "veins." Rosenhain was educated in the glass industry at Chance Brothers, Birmingham, England, and his nomenclature may be taken as orthodox in that locality at the beginning of the present century.

Hodkin and Cousen[10] use the term "striae" sparingly in their textbook. It has the same significance as in Rosenhain. They do not use the term "striation." They agree that the English equivalent is "veins" (p. 487), but seem to distinguish between "cords" and "striae" (p. 21), though only in passing. At the time their textbook was written, the authors' knowledge of the glass industry was limited, and the exact meaning of workshop terms was therefore not their primary concern.

F. E. Wright[11] uses the term "striae" freely, but not "striations." He offers as English equivalents "veins, cords, threads, ribbons, ream, etc." Wright, of course, obtained his knowledge of the glass industry when the U. S. Government set the Geophysical Laboratory staff to work on the production of optical glass for the United States, in 1918 or thereabouts.

The only other American textbook of consequence so far published (May, 1938), by Littleton and Morey,[12] does not seem to discuss the subject at all, and there appears to be no mention of striae, striations, or veins.

Returning now to English practice, the most complete treatment of the subject probably is Peddle's.[13] In the index, the word "striae" (plural) is listed as occurring on twenty separate pages. On some pages it occurs many times, and the word stria (in the singular) occurs perhaps four or five times all told.

The index does not mention "striations," and a perusal of the text fails to disclose any such term. The word "striated," meaning "containing striae," however, occurs at least twice. Thus on page 14, "A glass with a high content of calcium oxide is far more liable to be striated . . . ," and on page 18, "Stony metal always means striated glass."[14]

Hampton has recently published a paper[15] in which he adopts the term "striations" as synonymous with "striae" and defines them as "a lack of homogeneity," which is a little broad, inasmuch as the glass can contain other heterogeneities besides "striae." In this paper, Hampton does not use the term "vein" as the English equivalent of the Latin "stria."

In the United States, the confusion as to what is meant by a "striation" has been greatly complicated by the law courts. The trouble began with the suit of Smith *vs.* Peerless Glass Company *et al.*[16] Allen Rogers, testifying for plaintiff, claimed that defendant's glass exhibited "striations." The record does not indicate clearly what these striations really were, but they were pointed out in court without special apparatus and appear to have involved variations of wall thickness.

In a later suit, Riznyk *vs.* Owens-Illinois Glass Company *et al.*,[17] John C. Olsen, testifying for plaintiff, claimed the same deficiency, and pointed out as a "striation" the surface markings upon a fractured surface which the present writer (Preston) called "striations" in 1931. Olsen claimed to have been present at the Peerless trial and that what he (Olsen) claimed as "striations" were what Rogers had claimed as "striations."

In a still later trial, Hogan *vs.* Glenshaw Glass Company,[18] Allen E. Rogers, son of the first Rogers, again claimed "striations" as a defect, but testified that

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[6] F. W. Preston, "Propagation of Fissures in Glass and Other Bodies with Special Reference to the Split-Wave Front," *Jour. Amer. Ceram. Soc.*, **14** [6] 419–27 (1931).

[7] S. R. Scholes, Modern Glass Practice, p. 298. Industrial Publications, Inc., Chicago, 1935.

[8] F. E. Wright, "Manufacture of Optical Glass," *Ordnance Dept. Doc.*, No. 2037 (1924); Govt. Printing Office.

[9] Glass Manufacture, 2d ed. Constable, London, 1921; (1st ed., 1911).

[10] F. W. Hodkin and A. Cousen, Textbook of Glass Technology. Constable, London, 1925.

[11] *Loc. cit.*, p. 29.

[12] J. T. Littleton and G. W. Morey, The Electrical Properties of Glass. John Wiley & Sons, Inc., N. Y., 1933; Chapman & Hall, Ltd., London; *Ceram. Abs.*, **12** [12] 419 (1933).

[13] C. J. Peddle, Defects in Glass. Glass Publications, Ltd., London, 1927.

[14] This would read directly on the Peerless case, which refers to "the idiosyncrasies of striated glass."

[15] W. M. Hampton, "Optical Glass," *Jour. Soc. Glass Tech.*, **22** [89] 16–19 (1938); *Ceram. Abs.*, **15** [4] 120 (1936).

[16] Adeline Smith *vs.* Peerless Glass Company and Minck Brothers, reported in 259 N. Y. 292. (This case was decided by the New York Court of Appeals on June 1, 1932.) When we cite a case to a Judge or in a brief on appeal, we designate it as follows: Case reported in Volume 259 N. Y. at page 292.

[17] Emil Riznyk and Joseph Riznyk *vs.* Harkavay Beverage Co., Inc., Harry Harkavay, Bronx Mineral Water Co., Inc., Starman Siphon Manufacturing Co., Koscherak Bottlers Equipment Co., Inc., Albert Schneier, and Owens-Illinois Glass Co. This case was tried in the Supreme Court, New York County, on October 28, 29, 30, 31, and November 1, 1935, in the afternoon of which day the jury returned its verdict.

[18] Patrick J. Hogan *vs.* Glenshaw Glass Co., Inc., Admiral Bottling Works, Inc., and Jacob Resnick. This case was tried in the Supreme Court, New York County, on May 3, 4, 5, and 6, 1938; on the afternoon of the 6th the jury returned its verdict.

FIG. 4. "Striations" according to the Metropolitan Museum of Art (pitchers and candlestick, southern New Jersey type; American, about 1800). The glass jug on the left is decorated with bands of colored glass worked into the glass surface by the workmen, and the Museum refers to these as "striations."

striations were never visible without special equipment, such as polariscopes, ultra-violet light, or X-rays. As far as the present writer could understand the testimony and the comments of counsel for plaintiff, "striations" in this trial were essentially strains set up in the glass by a too brief, or imperfectly conducted, annealing process. They were also confused with "striae," which are not annealing strains.

At the moment, in the law courts, "striations" can apparently be (1) strains pure and simple, (2) variations of wall thickness, (3) fracture-surface markings called striations by the present writer, and (4) lack of homogeneity or striae of the textbooks. No doubt they will yet turn out to be still other things.[19]

In the laboratory or glass plant, at the moment, striations are apparently either (1) optical striae or "lack of homogeneity" or (2) de Fréminville's "stries," which are Preston's "striations." It might be an advantage to invent terms to distinguish the two phenomena, which have nothing in common (see Fig. 5).

Some of this confusion, perhaps most of it, has arisen from lack of an agreement as to the English equiva-

[19] (*a*) Thus in a book entitled, Glass, by the American Metropolitan Museum of Art in New York, the term "striations" is used to mean colored stripes worked into the glass by the workmen. The term occurs on p. 35 and the phenomenon is illustrated in the left-hand illustration of Fig. 30 of that book (see Fig. 4).

(*b*) Still another use for the word "striation" will be found on page 98 of Glass in Architecture and Decoration, McGrath and Frost, Architectural Press, London, 1937, where the authors quoting from M. L. Anderson, *Architectural Association Journal*, June–July, 1933, write as follows: "The peculiar character of crown glass has much to do with the very distinctive appearance of windows glazed with it. The slight curvature of the panes (which were glazed with the convex side outwards) gives a curious movement of light and shade with marked contrasts of tone, while the very slight striations produced by the act of spinning the table are generally discernible from the outside because of the play of light upon them, and their effect when seen from the inside is often very noticeable too. It has been explained that, during the course of manufacture, the glass never came into contact with any other surface; crown is the only type of window glass which can boast of this, with the result that its surfaces, being natural to glass as a material, are extremely brilliant and shiny. The curvature, striations, and bright surfaces of the glass together introduce an effect of extreme liveliness and sparkle to the appearance of the buildings."

Here the striations are faint ridges and grooves in the glass surface produced accidentally by the process of manufacture. They do not necessarily involve variations of glass composition, nor do they arise from abrasion, but are contemporaneous with the working of the glass.

FIG. 5.—"Striations" caused by fracture (according to Preston).

lent of the Latin "striae." There is apparently no ambiguity at present in glass plants as to what "striae" are, but they are entirely different from what the geologist calls "striae" (*v.* Chamberlin).

Twenty years ago, in England, there was no doubt in the optical industry as to the translation. "Striae" were "veins," and that term was used not only in Chance Brothers where optical glass was made, but also, as the present writer knows it first hand, in the optical glass-using establishments, such as Taylor, Taylor & Hobson, Ltd. Hampton, who is now Chance Brothers' chief of research, has apparently switched from "veins" to "striations" (see Fig. 6).

The term "veins" seems never to have had much currency outside the optical glass field. The same phenomena go by a great number of other names in the different branches of the glass industry.

Thus in the bottle industry, they are called "cords"; in the plate-glass industry "ream"; and in the wire-glass industry "lap." These are current American usage.

In the French optical glass industry, "stria" is rendered by "fil,"[20] which would naturally be rendered into English

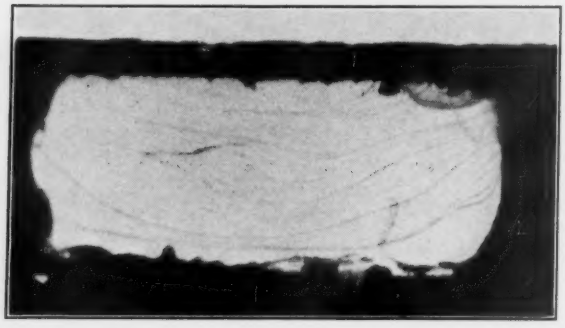

FIG. 6.—"Striations" in glass, in optical projection (after Hampton). The striations are faint heterogeneities in the glass mass, and to that extent they are comparable after a fashion with the metallurgical "striations" of Fig. 3.

as "thread." This is perhaps the most descriptive term for the heterogeneity as it occurs in optical glass. The thing commonly looks like a fine thread. But in the other glass industries where the same heterogeneity occurs, the "thread" tends to become flattened into a sheet, and its threadlike character is somewhat lost; hence Wright's "ribbons."

Apparently the French do not render "stria" by "strie," and I have not noticed them using "striation," which would look like perfectly good French.

Plurals: Adjectival and Verbal Forms

Stria is a Latin feminine singular; the normal Latin plural is *striae* which should take a plural English verb, and normally does. The Anglicized plural *strias* does not seem to occur, the word not having been "naturalized" as yet. In fact, outside academic circles and the optical glass industry, it is rarely used even in its Latin forms.

Wright[8] often treats striae as a singular; thus, "if the striae appears" (p. 31), "a heavy striae . ." (p. 32), "the same striae affects . ." (p. 32), but equally often he uses striae as a plural, *e.g.*, "no striae *are* visible" (p. 33), and again he uses the Latin singular, "a stria of a certain kind" (p. 33).

The present writer, having been brought up on a solid diet of Latin and Greek, can not admit the use of *striae* as a singular. It does not even look like a singular, and there is no excuse, as there is, for instance, in the word "data," where a neuter plural, looking like a feminine singular, is often used with an English singular verb; "data," however, is pretty well naturalized into English.

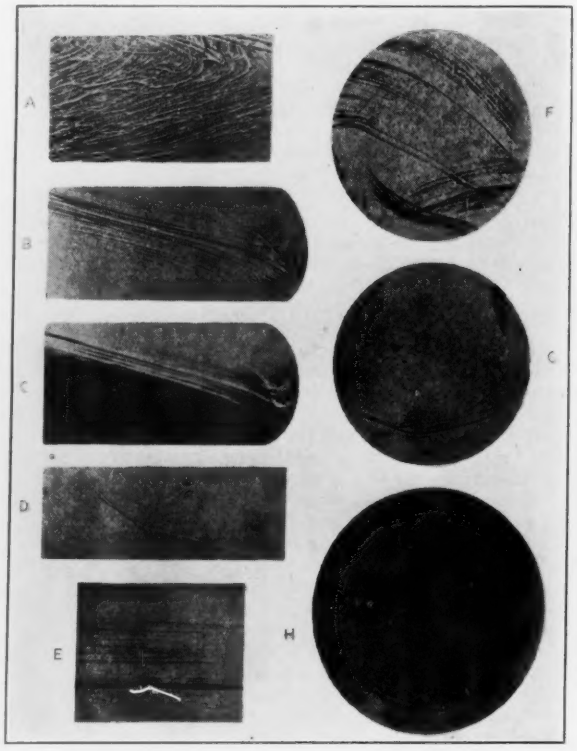

FIG. 7.—"Striae," "cord," "ream" (according to Wright); (*A*) heavy striae in a plate of glass; (*B*) ribbon striae (central illumination); (*C*) ribbon striae (oblique illumination); (*D*) cord in a plate of glass; stone with striae streamers near top of plate; (*E*) ream in rolled optical glass; (*F*) heavy striae in a lens; (*G*) cord and pressing defect in a lens; (*H*) ream cut across by the steep curve of a negative lens. In glass technology, there is no ambiguity about the word "striae," but a great deal about "striation," which is applied to four or five distinct phenomena.

Ream normally occurs in the singular, but Wright uses it once at least in the plural, *e.g.*, "the heavy reams are cut across." So does Peddle,[21] but Peddle quotes Wright at such length that perhaps this also is derived from Wright. Peddle, like Wright, uses "reams" only once, and "ream" (having a plural sense) many times. In many years in the plate glass industry I have never heard the plural in the shops. Apparently "ream" does not easily take either the definite or the indefinite article, especially the latter. Thus I can not recall ever hearing of "a ream." "The

[20] Chas. Dévé, Le Travail des Verres d'Optique de Precision. Ed. de la Revue d'Optique Theorique et Instrumentale. Paris, 1936.

[21] *Loc. cit.*, p. 6.

ream" is used, but "ream" is commoner. "Ream" is a condition, rather than an object; it is the condition of "being reamy." Thus it does not easily take a plural or an article; Wright (on p. 29) lists "ream" in the singular as the equivalent of five other words in the plural. *Striae* on the other hand are objects, not a condition (see also Fig. 7).

"Lap," as used in the wire-glass industry, has the same feeling as "ream." It does not easily take a plural or an article, but is the condition of "being lappy." Lap is not the same phenomenon here as in some other branches of the industry, where "a lap" is an actual folding over of the glass in the manufacturing operation.

jectival form, "veiny"; he does not report "veined" as heard in the shops.

The present memorandum deals primarily with the usage of words. It will be obvious that even if "striation" be identified with "stria," there is still a lot of confusion in the law courts as to the physical nature thereof, what means can be used to detect it, what it looks like when those means are employed, and what influence, if any, it has on the glass.

Detection of "Striations"

Ignoring now those "striations" of Preston, Olsen, and others, which are features of a fractured surface, and confining our attention to "veins," we may say that

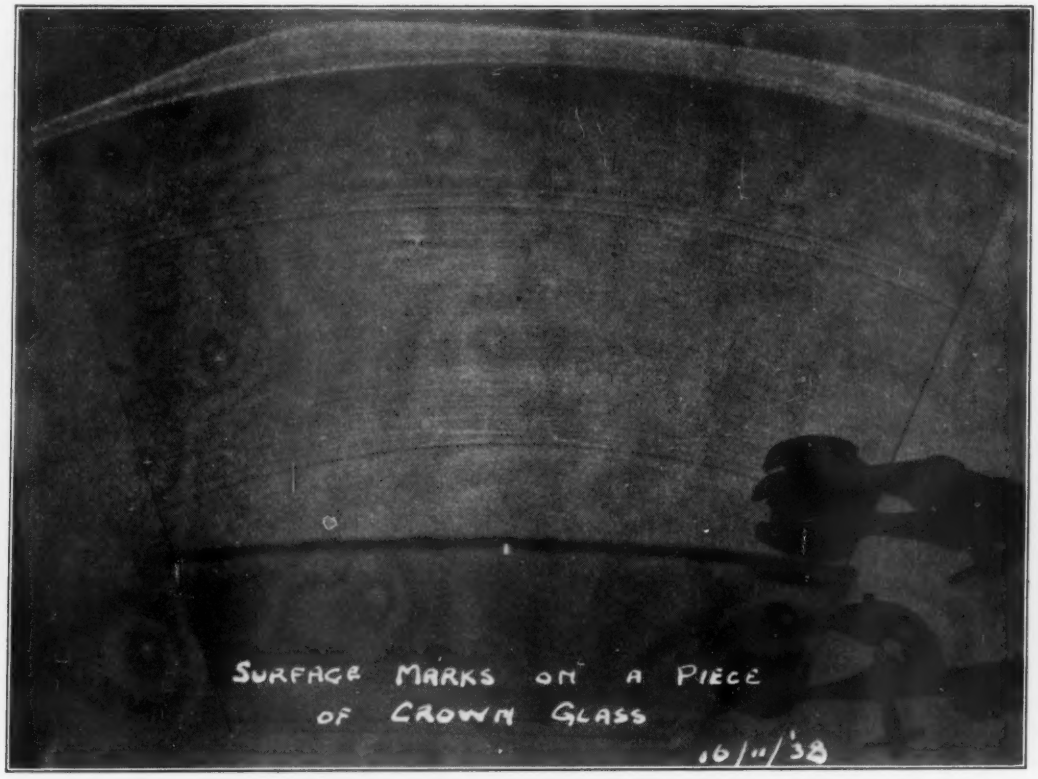

FIG. 8.—"Striations" (according to McGrath and Frost). These are surface markings, made while the glass is plastic, in process of manufacture (photograph supplied by W. M. Hampton).

"Cord" can occur in almost any grammatical form: "a cord," "the cord," "cords," in which form the word is synonymous with stria or striae. "Cord" can also stand alone as the exact equivalent of "ream," and meaning the condition of "being cordy," and "cordy" is a recognized adjectival form. There is no verbal form, "corded."

Wright admits "thread" and "ribbon" as the equivalent of "cord" or "vein." In that case they would form a normal plural, but for my own part I never met these terms in the shops, nor have I ever heard of glass being "thready," "ribbony," "threaded," or "ribboned."

The adjectival and verbal forms of striae must presumably be "striate" or "striated," of which only the latter seems to be known to date.

"Vein," according to Hampton,[22] gives rise to the ad-

"veins" are threads, layers, or ribbons of different chemical composition from their neighbors.

Such glass may be (1) of the same thermal expansion but of a different refractive index, (2) of the same refractive index but a different thermal expansion, or (3) different both in expansion and index.

Methods of detecting them will vary according to these circumstances. Thus type (1) can not be detected in a polariscope, but can be found by its deflecting power in parallel light. Wright, in fact, considers no other type and no other method, but says bluntly, "All methods for the detection of striae are based on the fact that the striae are of different refractivity from the surrounding

[22] Private communication.

glass."[23] He then devotes ten pages to the methods of detecting striae and never mentions the polariscope.

Type (2) would not be detectable by any of Wright's methods, but would give a polariscopic response; the effect in many cases would be very faint, as the length of the light path in the stria would often be insufficient.

Most cords will necessarily belong to type (3), because glasses of different chemical composition will usually be different also both in expansion and in index. Thus either the parallel light test or the polariscope may be used.

Peddle, however, denies flatly the utility of the polariscope for such purposes and says, "When testing for striae the Nicol is kept open." On this point, as far as it relates to optical glass, see the comments of G. W. Morey given here (p. 19). As far as it relates to bottle glass, Peddle's advice is inapplicable.

Where optical performance is required, the parallel light methods may be used or any of the methods outlined by Wright. Where *mechanical* performance of the glassware is desired, the polariscopic method is logical.

This paper substantially in its present form has been submitted to a number of technologists and men of science, with a view to discovering what is the current usage in glass factories here and abroad. Obviously, this is more important than what we find in the literature, for books and scientific papers are a very small part of the use that is made of the English language. All of them have given me answers, and some of their observations are given here.

Bernard Long, Director, Research Laboratories, St. Gobain Glass Works, France: "The literal translation (into French) of stria and striae is clearly strie and stries, but I must add that in the language of glassworkers, it is exceptional for striae to be rendered as 'stries.' Current French usage gives 'fils,' 'cordes,' 'ondes' (threads, cords, waves) as the equivalent of 'striae.'

"'Strie' in the language of glassworkers is used to designate surface asperities rather than defects of the glass substance."

In rolled glass, we call "strie" (striated), glass which has parallel ribs on one of its faces produced by a printing roll (*e.g.*, "ribbed wire glass."—F. W. P.)

"Again in Fourcault sheet glass, we get 'stries' as a result of the dragging, into sheets, of threads of glass more aluminous than the rest, confined only to a part of the lateral surface of the sheet."

Fred E. Wright,[24] Geophysical Laboratory, Washington, D. C.: "I consider that 'striae' should refer preferably only to lines or bands of glass whose composition is slightly different from that of the enveloping host; that 'striations,' if the word must be used, should refer to surface markings that are caused by fracture or other process and are not inherent in the glass itself but can be removed by mechanical operations; whereas 'striae' are inherent in the glass itself and are the expression of its inhomogeneity. I regret that, through oversight, I used 'striae' as the singular form; am surprised that I did so. With reference to 'ream,' it has always been my understanding that, in the plate-glass industry, the layers of slightly different composition parallel with rolled surfaces are called 'ream.' It is possible that my usage of ream in the plural was not quite according to Hoyle; however, it was so used at one plant I visited.

"I do not remember ever to have heard the word 'striations' used to refer, in poorly annealed glass, to the isochromatic lines observed in polarised light. I hope this usage will not become general."

(Dr. Wright's suggestion, to distinguish sharply between "striae" and "striations" as two totally different phenomena may be a very good one, and it may not be too late to agree on it. Hampton apparently feels the same way.—F. W. P.)

W. M. Hampton, Chief of Research, Chance Brothers, England: "The phenomenon, whatever we call it, is fundamentally a lack of homogeneity. I think it is really 'lack of homogeneity as shown by an optical projection method,' *i.e.*, when the material contains other material whose refractive index is different and the change from one refractive index to another is sufficiently abrupt to give either a definite shadow or lens effect. As far as I am concerned, 'veins' and 'cord' (the latter term being used almost exclusively in the plate-glass industry here) are interchangeable terms and are used when the material causing the heterogeneity is sufficiently well defined to look like a thread. In the case of blown glass, such threads may lie on the surface and in that case they are commonly known as 'string,' but as far as I know the cause is exactly the same, a material of different refractive index and presumably a different viscosity, so that it has not been incorporated sufficiently into the bulk of the glass. 'Striae' is a term which is used more generally here when the veins are more diffuse; we used to have an old sorter who talked about the glass looking 'greasy,' which gives exactly the appearance that we should describe as 'striae.'

"I am afraid that I have no justification for the use of the word 'striation,' and I can not remember now why I used it except as a sort of general term covering all sorts of defects due to lack of homogeneity."

(Hampton and Wright are both supported by Gregorius. —F. W. P.)

J. S. Gregorius, Research Laboratory, Pittsburgh Plate Glass Company: "The term 'striae' of optical-glass manufacturing parlance corresponds to the term 'ream' in flat-glass parlance.

"The word 'striation' typifies, for me, the result of some force or action that has scored or marked a surface, and in that sense differs tremendously from 'striae,' which are things that form in a glass body in the 'borning.'

"A homely illustration of 'striae' is the appearance of hairlike configurations that result when treacle or rock candy is placed in a drinking glass and dissolved in water. The hairlike configurations persist until mechanical stirring or normal diffusion forces produce a homogeneous liquid. Certain glasses, especially the dense lead, have such a strong tendency to form 'striae' that normal diffusion forces must be assisted by mechanical stirring while the glass cools to within a few hundred degrees Fahrenheit of its congealing temperature."[25]

[23] This statement is repeated verbatim by Peddle, *loc. cit.*, p. 30.

[24] Letter written from Mount Wilson Observatory, June 28, 1938.

[25] Peddle uses a similar illustration, the mixing of glycerine and water, *loc. cit.*, p. 9.

Gregorius gives a good deal of valuable technical data, which are omitted, as we are dealing principally with terminology. He does, however, give a couple of further notes on the latter subject, *viz.*, "'Cords' in flat-glass parlance are oftimes termed 'strings,' and in this case a 'string' is definite because it always denotes that a nonglassy fragment is associated with the string or that the nonglassy fragment has been very lately assimilated and has left a nucleus of glass that differs in refraction as well as viscosity from the general glass mass.

"'Ream' in flat-glass parlance is identical with 'striae,' and as used denotes a plural sense because a single ream is indeed rare."

Wilbur Brown, Libbey-Owens-Ford, Toledo, Ohio, states that he uses "striated glass" as the equivalent of glass containing "striae." Apparently, he does not use the term *striations* at all. "Striae" are synonymous with "unhomogeneous glass," and the lack of homogeneity may be anything from very slight to "so heavy that the glass is all cullet."

In *plate* glass, unhomogeneous glass may be marked by the inspectors as defective in respect either of "string" or "ream." In window glass, the terms are "string," "smear," "cords," and "lines."

(Brown gives a lot of technical data which I omit here. I call attention, however, to the term "smear" which he alone reports.—F. W. P.)

Bernard Long reports the French version as "peignage," a "combing," as if something were lightly wiped over the glass with a comb. Both Brown and Long agree that this is due to streaks of glass more aluminous than the rest.

Brown adds, "I have never heard the term (ream) used in the factories except in the singular."

Walter E. Schweppe, Factory Manager, Franklin Glass Corporation, confirms Gregorius and Brown, that "ream" is always singular. In discussion with his inspectors, he finds the terms ream, cord, and cordy well understood, but that striae, striation, and veins mean nothing to them.

Frank E. Troutman, President, Standard Plate Glass Company: "It never occurred to me before that 'ream' could have a plural; it is certain I never heard it. 'Cords' and 'strings' are, to me, just a long and narrow species of 'ream.' The word 'striae' to me means something approximating to a definite lamination, and ream is the optical effect of the striae."

(In other words, the objects producing the lamination are "striae"; the optical effect (the greasy look mentioned by Hampton) is "ream."—F. W. P.)

Troutman calls attention to the fact that while striae in moderation have no influence on surface marks when fracture takes place, very heavy ream may imply a virtual discontinuity and influence the fracture visibly.

George E. Howard and *V. C. Swicker* both call attention to the same fact, but this has no bearing on nomenclature.

L. T. Sherwood would agree that this is true also of "lap," as used in the factory of the Pennsylvania Wire Glass Company.

H. A. Wadman, Hartford-Empire Company, corroborates Troutman, "I have always associated 'striae' with 'ream' or a general *distributed* cordiness." (I take this to be equivalent to a generally laminated condition. —F. W. P.)

"I should prefer to clarify the usage by defining the ordinary striae as 'refractive striae,' and surface markings as 'propagation striae.'

(Wadman's suggestion is clear but entirely contrary to the general sentiment, which is to use "striae" alone to mean what it has always meant, and to apply any qualifying epithets to "striation," which is the word giving all the trouble.—F. W. P.)

Donald E. Sharp, Hartford-Empire Company, concurs in the general attitude. "The words 'stria' and 'striae' are in well-established use in the optical industry and are clearly understood to mean internal defects. 'Striae' is synonymous with 'cords' in this industry. It is evident to the glass technologist that the words are synonymous, as used in the container industry, although the dictionary definition may not indicate this."

G. W. Morey, Geophysical Laboratory, Washington, D. C., who was in charge of optical-glass manufacture at the Spencer Lens Company plant, Hamburg, N. Y., during the war, comments a little more specifically. "I think of striae as being a more diffuse type of heterogeneity, of threadlike and cordlike masses; of 'cord' and 'ream' as being of identical meaning but referring to much coarser degrees of homogeneity.[26] I have never heard a glass man speak of *striations*." (The italics are Morey's.)

(George: This is a little tough on Scholes and Hampton, as it might suggest they are not glass men! But both of them have actually expressed regret at having used the term.—F. W. P.)

Morey continues (referring to optical glass): "This is the first time I have heard of the method of distinguishing 'striae' by the polariscope test, although I used it as a practical test in manufacture. I should like to see evidence on the sensitiveness of this test in glass of optical type in which striae are of importance. I would expect it to be inferior in sensitivity to the optical set-up described by Wright, but I may be wrong. I think the probability of striae of the same index is not great; and I wonder if fine striae of such type would show up with a polariscope. At the same time, in favor of that view, is my own experience, in which the polariscope was the first cause of rejection of striated borosilicate crown binocular prism and gave no difficulty from failure to detect imperfect glass."

J. C. Hostetter, Director of Research, Hartford-Empire Company, commenting on the Morey statement, observes: " I should like to comment on the type of cords having the same index of refraction as the parent glass. In the manufacture of bulbs, there were occasions when we would have present what the inspectors would call 'chill cords.' On examination of the bulb submerged in an index liquid, these cords would disappear. However, if the sample, while submerged, was examined in parallel light, as described by Dr. Wright, there would usually be associated with the chill cords some extremely fine composition cords, the latter occupying an area only a few per cent of that covered by the chill cords. I am convinced that chill cords actually exist under some condi-

[26] Morey is confirmed by Peddle (*loc. cit.*, p. 12), "thick parallel streaks are 'ream.'"

tions, but I have never quite convinced myself as to the exact cause of the fine composition cords present in the chill cord area."

The choicest comment comes from *J. T. Littleton*, Corning Glass Works, Corning, N. Y.

"It seems to me that you have shown that according to common usage the word 'striation' has no accepted meaning. Consequently, whenever it is used, it should be defined . . . ."

(This is a gentle hint that the present paper is unnecessary, and I am inclined to agree with J. T., as I generally do.—F. W. P.)

J. C. Hostetter and *Bert W. Hendrickson* (trial counsel and legal adviser to the Glass Container's Association) hold the contrary view, however, and desire an end to the confusion.

I fear that there can be no end, however, except by the processes laid down by Littleton, for clearly anything is a striation that can pass a dictionary definition, and we can not restrict the use of the English language. It is, however, clear that there is a strong general sentiment to distinguish sharply, for technical purposes, between "striae" and "striations," and that all the writers who have used "striations"[27] as the equivalent of "striae" are willing to abandon such usage for the sake of clarity.

[27] Except perhaps the law courts.

Box 847
Butler, Pennsylvania

REINFORCED BRICK PAVEMENTS*

By H. Z. Schofield

Abstract

A description is given of a reinforced brick pavement slab and reinforced brick pavement resurfacing constructed in Illinois. A laboratory study which indicated the importance of rod anchorage in this type of shallow slab is mentioned. Plans are presented for an experimental reinforced brick pavement to be constructed in Ohio in 1938. Reinforcing by loose bars, welded wire fabric, and bar mat will be employed in this project.

I. Introduction

In 1931, a reinforced brick slab was constructed which has spanned a 5-foot square excavation and has successfully borne the heavily loaded trucks (Fig. 1). There was no preparation of the subgrade except sand, which was spread as a thin leveling course. Wire-cut brick ($2^1/_2$ inches) were laid on edge in basket fashion so that three brick constituted a unit $8^1/_2$ inches square and 4 inches deep. Deformed $^3/_8$-inch reinforcing rods were placed at 9-inch centers, both longitudinally and transversely, and at somewhat less than one inch above the slab bottom. The joints were then flushed with cement grout (1 part cement, 2 parts sand).

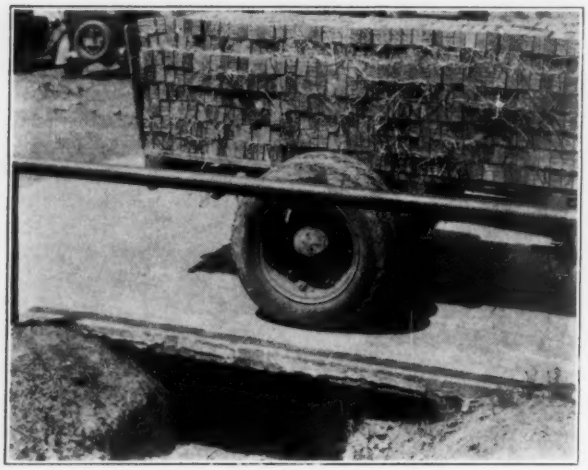

Fig. 1.

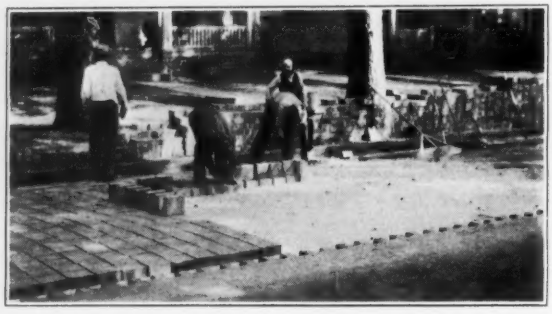

Fig. 2.

A 75-foot length of a 34-foot street in Springfield, Illinois, was resurfaced in 1937. The old brick surface course was removed and the old cement-sand cushion (on concrete base) was leveled with a thin sand cushion. Over this entire section, a single slab was constructed (Fig. 2) with brick units of 8 by 8 by $3^1/_2$ inches.

In 1936, at the Ohio State University Engineering Experiment Station, a study was made of

* Presented at the Fortieth Annual Meeting, American Ceramic Society, New Orleans, La., March 30, 1938 (Structural Clay Products Division).

reinforced brick slabs of 4-inch depth. The first slabs were reinforced with straight rods. In later slabs, the rods extended beyond the slab ends, and nuts and washers were placed on the rod ends to prevent movement of the rods. The load-bearing ability of the slabs was thus enormously increased.

II. Present Plans

Plans are now complete for construction of an experimental reinforced pavement 200 feet long and part of a heavily traveled 20-foot highway.

One-third of the 200-foot length will be constructed in the manner employed in the Illinois

FIG. 3.

experiments. The brick have a wearing surface 8 inches square and are $3^3/_4$ inches deep. These dimensions provide the possibility for use of off-grade lots in backup work, because when laid on edge each is equivalent to three common brick. The brick units will be laid with unbroken 1-inch joints (both longitudinally and transversely) on an unprepared subgrade, except for checking its stability and spreading a thin leveling course of sand. Laying of the brick will be controlled by a notched board templet (Fig. 3). The $^3/_8$-inch round, deformed reinforcing rods of intermediate-grade new billet steel will then be placed in each joint, both longitudinally and transversely and will be supported $^3/_4$ inch above the brick bottom. The whole will be flushed with a grout (probably one part cement and three parts sand).

At the pavement edge, rods (24 inches long) will be inserted, immediately after grouting, to a depth of $^3/_4$ inch in each transverse joint for one-half of the length of one pavement edge. This added reinforcement, of course, anticipates tension in the slab top due to wheel loads near or on the pavement edge. The ends of all transverse rods for one-half of the length of the opposite pavement edge will be hooked through 180° within the joint.

Two other means of rod anchorage will be tried, *viz.*, "welded wire fabric" and "bar mat." The welded wire fabric consists of longitudinal and transverse wires of gage No. 0 (approximately 0.3 inch diameter), high-yield point, cold-rolled steel spaced at 9-inch centers in both directions, and welded at each wire intersection. This fabric will be placed at the center of the slab depth to act as a restraint against crack formation. The fabric sheets will be supported at the necessary height above the sand leveling course; thus the fabric meshes will serve as guides for brick unit placing. The section will then be flushed with the cement grout.

The bar mats prepared differ from the welded wire fabric only in that the bars are $^3/_8$ inch round, of intermediate grade steel, and the sheets are much larger, thus requiring less splicing of adjacent sheets. The mats will be supported $^3/_4$ inch above the sand leveling course, and the brick units will be centered in the mesh openings. Immediately after grouting, 24-inch rods will be inserted to a depth of $^3/_4$ inch in each transverse joint along one pavement edge. The outside courses of brick units will be enclosed within reinforcement meshes; the steel thus exposed along the pavement edge will be encased with cement grout for protection against rusting.

RESEARCH BUREAU
NATIONAL PAVING BRICK ASSOCIATION
ENGINEERING EXPERIMENT STATION
OHIO STATE UNIVERSITY
COLUMBUS, OHIO

ACTIVITIES OF THE SOCIETY

PROPOSED RULES OF THE GLASS DIVISION OF THE AMERICAN CERAMIC SOCIETY*

These proposed rules of The Glass Division are based on the By-Laws of the Division as published on page 224 of the May, 1937, *Bulletin*, and page 375 of the September, 1926, *Bulletin*. Those portions in italics represent new material which is required to make these rules consistent with standard form and the new Constitution, Rules, and By-Laws of the American Ceramic Society (see *The Bulletin*, October, 1938, pp. 385–93).

—A. N. FINN, *Chairman, Rules Committee*

Article GR I. Name

The official title of this Division shall be The Glass Division of THE AMERICAN CERAMIC SOCIETY.

Article GR II. Purpose

(1) It shall be the purpose of this Division to stimulate the growth and activities of THE SOCIETY in the arts and sciences pertaining to the glass industry.

(2) This Division shall represent THE SOCIETY in matters pertaining to the glass industry, when specifically authorized by the Board of Trustees.

Article GR III. Membership

(1) The Glass Division shall consist of those Fellows, Members, Corporation Members, and Life Members of these grades of THE AMERICAN CERAMIC SOCIETY in good standing, who have instructed the General Secretary of THE SOCIETY to so enroll them.

(2) The following grades of members enrolled in this Division shall be entitled to vote: Fellow, Member, Voter of Corporation Member, and Life Member of these grades.

(3) The following grades of members enrolled in this Division shall be entitled to hold office: Fellow, Member, and Life Member of either grade.

Article GR IV. Government

(1) The Executive Committee of this Division shall consist of the Chairman, First Vice-Chairman, Second Vice-Chairman, Secretary, and Divisional Trustee.

(2) The term of office of the Chairman, First Vice-Chairman, Second Vice-Chairman, and Secretary shall be one year, to wit: from the close of one Annual Meeting of THE SOCIETY to the close of the next succeeding Annual Meeting, or until their respective successors have been elected and duly qualified. The term of office of the Trustee representative of this Division shall be three years, to wit: from the close of one Annual Meeting of THE SOCIETY to the close of the third succeeding Annual Meeting, or until his successor has been elected and duly qualified.

(3) The duties of the Executive Committee shall be *to transact such interim business as may be referred or delegated to it by the General Society, or by this Division*, to appoint a new Second Vice-Chairman or Secretary, when necessary, to fill an unexpired term, *and to act as consultant and adviser to the other committees of this Division.*

Article GR V. Meetings

(1) The annual business meeting of this Division shall be held during the week of the Annual Meeting of THE SOCIETY.

(2) *Twenty voting members of this Division shall constitute a quorum at the annual business meeting or at any special business meeting.*

Article GR VI. Officers

(1) (*a*) The Chairman shall have general supervision of the affairs of the Division. He shall, *if present*, preside at all meetings of the Division and shall be a member of the Committee on Sections and Divisions of THE SOCIETY.

(*b*) The Chairman shall appoint representatives of this Division to those Standing Committees of the Society, as provided by the Constitution and By-Laws of THE SOCIETY, and to such special committees as may be required by THE SOCIETY. He shall also appoint the chairmen of the necessary committees of this Division, except the Executive Committee and the Committee on Papers and Program, which are otherwise provided for.

(*c*) The Chairman shall prepare a report on the activities of the Division during the year, which report shall be presented at the business session of the Glass Division at the Annual Meeting. He shall also submit this report, in brief form, for publication in *The Bulletin*.

(2) The First Vice-Chairman shall assist the Chairman and shall succeed to the powers and duties of the Chairman in the event of the refusal or incapacity of the Chairman to act.

(3) (*a*) The Secretary shall keep minutes of all Division meetings and a full record of the correspondence of the Division. He shall perform such other duties as the Chairman may properly assign to him.

(*b*) The Secretary shall also prepare and submit for publication, in the first issue of *The Bulletin* after the Annual Meeting, the proceedings of the Division at said Meeting.

(4) The Second Vice-Chairman shall assist the Chairman and First Vice-Chairman and shall succeed to the powers and duties of the First Vice-Chairman in the event of the refusal or incapacity of the First Vice-Chairman to act.

(5) Interim vacancies are to be filled as stated under duties of the Executive Committee.

Article GR VII. Nominations and Elections

(1) (*a*) The Division representatives elected to THE SOCIETY Nominating Committee A and to THE SOCIETY Nominating Committee B shall together act as the Executive Nominating Committee of the Division and shall be nominated and elected as follows:

(*b*) Nominations of at least two Division candidates for Committee A and at least two Division candidates for Committee B shall be made by the Executive Committee of this Division at least ninety (90) days prior to the Annual Meeting.

(*c*) Election, by secret written ballot, shall be as detailed in Article GR VII, Sections (4) (*a*) and (*b*) hereof.

(2) The Nominating Committee of this Division shall consist of three members appointed by the Chairman. The Division Nominating Committee shall nominate one person for each office of Chairman, First Vice-Chairman, Second Vice-Chairman, and Secretary. The nominations shall be submitted to the members of the Division during the first regular meeting of the Division, and voting shall be on the second day during the business meeting.

(3) Ten members of this Division can make a nomination for (1) officers elected annually, by submitting a formal petition to the Chairman of this Division at the first regular session of the Division at the Annual Meeting of THE SOCIETY, and for (2) Trustee by submitting a petition to the Chairman at least ninety (90) days prior to the Annual Meeting.

(4) (*a*) The Division Nominating Committee shall also, when properly notified, nominate a candidate for the office of Trustee representative of this Division and shall certify

*Received December 16, 1938.

his name, together with his acceptance in writing, to the Chairman of the Division at least ninety (90) days prior to the Annual Meeting of THE SOCIETY at which the triennial term of the Trustee representative expires.

(*b*) The Chairman of the Division shall transmit the nominations to the General Secretary of THE SOCIETY who shall submit ballots by mail to the voting members of the Division at least sixty (60) days prior to said Annual Meeting of THE SOCIETY. The ballots shall bear the names of the nominees and the closing date of the voting. The ballots shall be returned to the Chairman of the Division in a plain envelope marked only with the words "Division Ballot." This envelope shall be enclosed in another envelope for mailing, upon the back of which the voter shall endorse his name. Only those ballots so returned thirty (30) days before the opening date of the said Annual Meeting shall be counted.

(*c*) The Chairman of the Division shall have the ballots counted immediately after the close of the voting and shall transmit the results of the election to the General Secretary.

(5) (*a*) In the event of the refusal to act, or incapacity to act, of the Trustee representative of this Division, a successor to fill the unexpired term shall be elected prior to the next succeeding Annual Meeting of THE SOCIETY as provided in Article GR VII, Section (4) hereof.

Article GR X. Relations with Society

(1) As soon as possible after each Annual Meeting of THE SOCIETY, the Chairman of the Division shall fill all vacancies on the Standing Committees of THE SOCIETY as currently required by the By-Laws.

(2) The Chairman of the Division shall promptly appoint Division representatives to special committees of THE SOCIETY upon notification from the President of THE SOCIETY.

(3) The Division shall not expend funds of THE SOCIETY or incur indebtedness without the formal approval of the Board of Trustees.

(4) The provisions of the Constitution, By-Laws, and Rules of THE SOCIETY shall govern the procedure of all Divisions, but no action or obligation of a Division shall be considered an action or obligation of THE SOCIETY. This By-Law shall be imprinted on any publication issued by a Division.

Article GR XII. Committees

(1) The Standing Committees of the Division shall be as follows:

(*a*) Rules
(*b*) *Editorial*
(*c*) Membership
(*d*) Standards
(*e*) Papers and Program
(*f*) Research
(*h*) Data
(*i*) Education
(*j*) *Industrial Management*

(2) The Chairman of the Rules Committee shall be appointed as provided in Article GR VI, Section (1) (*b*), and said Chairman shall be Division representative on the Rules Committee of THE SOCIETY.

(3) The Editorial Committee shall be appointed as provided in Article GR VI, Section (1) (*b*). It shall be the duty of this committee to act in coöperation with the Editor of the publications of THE SOCIETY and the Committee on Publications of THE SOCIETY as the By-Laws and Rules of THE SOCIETY may currently specify.

(4) The Chairman of the Membership Committee shall be appointed as provided in Article GR VI, Section (1) (*b*), and said Chairman shall be Division representative on the Membership Committee of THE SOCIETY.

(5) The Chairman of the Standards Committee shall be appointed as provided in Article GR VI, Section (1) (*b*), and said Chairman shall be the Division representative on Subcommittee C and Subcommittee D of the Standards Committee of THE SOCIETY.

(6) The Committee on Papers and Program shall consist of the First and Second Vice-Chairmen, formally elected at the last Annual Meeting, or as otherwise provided for in Article GR IV, Section (3).

(7) The Chairman of the Research Committee shall be appointed as provided in Article GR VI, Section (1) (*b*), and said Chairman shall be Division representative on the Research Committee of THE SOCIETY.

(9) The Chairman of the Data Committee shall be appointed as provided in Article GR VI, Section (1) (*b*), and said Chairman shall be Division representative on the Committee on Data of THE SOCIETY.

(10) The Chairman of the Committee on Education shall be appointed as provided in Article GR VI, Section (1) (*b*).

(11) The Committee on Industrial Management shall consist of one member only who shall be appointed as provided in Article GR VI, Section (1) (*b*), and said member shall be Division representative on the Committee on Industrial Management of THE SOCIETY.

General

(*a*) The Division Chairman may appoint the membership of the foregoing committees, but the Chairman will, in general, appoint the members of his respective committee, and inform the Division Chairman, Division Secretary, and General Secretary accordingly.

(*b*) All committeemen shall hold office for the term for which the Divisional officers have been elected, except the Standards, Data, and Research Committees, which shall consist of three (3) members each, one of whom shall be appointed each year to serve for three (3) years.

(*c*) Each Committee Chairman shall prepare a written report of his committee's activities during the year, said report to be presented at the business session of the Glass Division at the Annual Meeting. The report should be submitted to the Chairman before the meeting so that ample time can be allotted for the presentation of all reports at the business session.

(*d*) *The duty of these several committees is to stimulate the activities of the Division and of* THE SOCIETY *along the lines indicated by the titles and, when in doubt, each Chairman should communicate with the Chairman of the corresponding Committee of* THE SOCIETY.

Article GR XV. Amendments

These rules of the Glass Division may be amended as follows: Amendments may be proposed *by the Rules Committee or* by a petition from twenty (20) members of the Division. In either case, the proposed amendment shall be submitted to the Chairman at least ninety (90) days before the Annual Meeting. Through the Secretary, he shall submit the proposed amendment, with letter ballot, to the membership at least sixty (60) days before the Annual Meeting. All ballots returned before the business session at the Annual Meeting shall be counted. If two-thirds or more of the Division membership vote for adoption of the amendment, as proposed, the Chairman shall declare it adopted.

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MINUTES OF MEETING OF THE WHITEWARE ADVISORY COMMITTEE ON RESEARCH OF THE AMERICAN CERAMIC SOCIETY

The meeting was called to order at 10:10 A.M., November 14, 1938, in Room 301, Industrial Building, National Bureau of Standards, Washington, D. C.

Those present were S. J. McDowell, *Chairman;* J. R. Beam, H. C. Harrison (R. A. Snyder), F. H. Riddle, Edward Schramm, A. V. Bleininger, and M. Sweitzer (guest). A. H. Fessler, D. P. Forst, and Don Hagar, members of this Committee, were absent.

The National Bureau of Standards was represented by R. T. Stull, T. A. Klinefelter, W. W. Meyer, G. R. Shelton, E. N. Bunting, A. S. Creamer, and R. F. Geller.

The meeting was devoted to a discussion of the various problems in the course of investigation at the Bureau or which have been suggested during previous committee meetings.

(1) Glazes

The study of temperature-viscosity relations as applied to the development of commercially satisfactory glazes. This problem is to be retained for future consideration, but no investigation has been started.

(2) Glass

A study of the glass phase in whiteware bodies (with the suggestion that this be amplified in time to include a study of the glass matrix *in situ* and also glasses melted *in vacuo vs.* normally melted glasses and correlated with problem (1)).

One paper has been published by G. R. Shelton and W. W. Meyer,[1] and the problem is to be retained for further consideration.

(3) Bodies

An X-ray study of commercial bodies. Work on this problem has been hampered by stress of other investigations and also by lack of X-ray facilities, although the latter condition has since been corrected. The most interesting outcome of the studies made was to show that calcium pyrophosphate is a constituent of bone china.

(4) Glazes

The determination of the amount of lead oxide and boric oxide lost from whiteware glazes by vaporization (this problem would be considered as a part of problem (5)). No investigation has been made dealing specifically with this problem, time available having been devoted to problem (5).

(5) Glazes

A fundamental investigation of the course of the reactions taking place during the fusion of those oxides used in the manufacture of glazes.

Investigations under this problem of the binary and ternary systems containing PbO, of interest to manufacturers of ceramic glazes and glasses, have been continued in the study of the system $PbO–B_2O_3–SiO_2$. A report has been published[2] on the system $PbO–B_2O_3$ and on the compositions in this system studied as glasses.[3] E. N. Bunting gave a report to the meeting on the present status of the phase equilibria study in the system, which study is nearing completion. The Bureau has approved the continuation of this fundamental investigation by a study of the ternary system $PbO–Al_2O_3–SiO_2$.

(6) Bodies

An investigation of gas-temperature relations with particular reference to those gases present in ceramic kilns at temperatures used in the manufacture of whiteware and including an investigation of the effects of these gases on whiteware bodies during the firing process.

No investigational work has been started, but the problem is being retained for future consideration.

(7) Bodies

A study of whiteware bodies under high-power magnification using ultra-violet and other light sources.

Same as problem (6).

(8) Method

A study of the mechanics of dry-pressing including the determination of the relative effects of particle size and distribution in the body, the amount and nature of the fluid used, and the composition and condition of the atmosphere in which the pressing took place.

Same as problem (6).

(9) Effect of Talc in Whiteware Bodies

Future work to be incidental to other studies. Dry-pressed and extruded specimens were made of 12 talcose bodies which were modifications of the body designated as No. 8 in the report on "Talc in Whiteware."[4] These specimens were bisque-fired in the electrically heated tunnel kiln to cones 4, 6, and 8 on 9-, 16-, and 24-hour cycles. The effects of these treatments on the linear shrinkage and modulus of rupture of the bodies were reported by A. S. Creamer.

10) Studies of Strains in Glaze by Optical Methods

With special emphasis on investigations with the thermal microscope. No investigational work has been started, but the problem is being retained.

(11) Hardness of Ceramic Surfaces

An apparatus has been constructed and a considerable number of plates submitted by various manufacturers of vitreous and semivitreous tableware has been tested. A report of the results obtained was summarized for the committee by R. F. Geller, but no conclusions could be presented at this time.

(12) Study of Ball Clays

Their constitution, soluble salts, colloidal phenomena, effect of natural and added organic matter, and action in whiteware bodies.

W. W. Meyer reported on the ball-clay investigation. Special apparatus being used was described. The Fe_2O_3 and TiO_2 contents of the clays were compared. The ultimate p_H values and base exchange capacities at p_H7 of the leached and electrodialyzed clays were given. The amounts of organic matter removed from the clays by treatment with H_2O_2 were reported and also the ultimate p_H values and base exchange capacities at p_H7 of the clays after H_2O_2 treatment. A comparison was made between the RO contents and the base exchange capacities of the clays. —R. F. GELLER, *Acting Secretary*

NATIONAL PAVING BRICK ASSOCIATION

The Thirty-Third Annual Meeting of the National Paving Brick Association will be held in Columbus, Ohio, February 1–3, 1939, at the Deshler-Wallick Hotel. In addition to the business meetings, many of the sessions will be open to the general public. Those interested in street and highway development are cordially invited to attend.

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[1] G. R. Shelton and W. W. Meyer, "Nature of Glass Phase in Heated Clay Materials: II," *Jour. Amer. Ceram. Soc.*, **21** [11] 371–85 (1938).

[2] R. F. Geller and E. N. Bunting, "System $PbO–B_2O_3$," *Jour. Research Nat. Bur. Stand.*, **18** [5] 585–93 (1937); R.P. 995; *Ceram. Abs.*, **16** [8] 260 (1937).

[3] R. F. Geller, E. N. Bunting, and A. S. Creamer, "Some 'Soft' Glazes of Low Thermal Expansion," *Jour. Research Nat. Bur. Stand.*, **20** [1] 57–66 (1938); R.P. 1064; *Ceram. Abs.*, **17** [4] 130 (1938).

[4] R. F. Geller and A. S. Creamer, "Talc in Whiteware," *Jour. Amer. Ceram. Soc.*, **20** [5] 137–47 (1937).

AMERICAN CERAMIC SOCIETY FORTY-FIRST ANNUAL MEETING

Tentative Program Outline Schedule—April 16–22, 1939

Hotel Stevens—Chicago, Illinois

	Sunday April 16	Monday April 17	Tuesday April 18	Wednesday April 19	Thursday April 20	Friday and Saturday April 21–22
Breakfast		7:30 A.M. Editorial	7:30 A.M. Editorial	7:30 A.M. Divisions and Sections		
Morning	Board of Trustees—Room No. 4	9:00 A.M. General Session—Symposium: "Importance of Thermal History," led by G. A. Bole—North Ball Room	9:00 A.M. Division Meetings Art—Room No. 1 Enamel—Boulevard Room Glass—North Ball Room Materials and Equipment—North Assembly Refractories—South Ball Room Structural Clay Products and Terra Cotta—Room No. 2 White Wares—West Ball Room		Division Meetings and Plant trips	Plant trips
Noon	Ceramic Educational Council		Editorial	Divisions and Sections	Board of Trustees	
Afternoon	2:00 P.M. Ceramic Educational Council—Room No. 2 4:00 P.M. Fellows Meeting—North Ball Room	2:00 P.M. General Session—Symposium: "Glaze and Enamel Properties," led by F. H. Norton—North Ball Room	2:00 P.M. Division Meetings		Board of Trustees Plant trips	Plant trips
Night	7:00 P.M. Dinner 9:00 P.M. Edward Orton, Jr., Memorial Fellow Lecture—Grand Ball Room	6:30 P.M. Keramos Dinner Meeting 8:00 P.M. Board of Trustees—Room No. 4	6:00 P.M. College Alumni Dinners 9:00 P.M. Student Reception—Boulevard Rooms	7:00 P.M. Institute of Ceramic Engineers—North Assembly		

AMERICAN CERAMIC SOCIETY GENERAL MEETING

Saint Francis Hotel, San Francisco, Calif., August 6–12, 1939

Ceramic Art Exhibits

Members of the American Ceramic Society attending the General Meeting in San Francisco next August will have an opportunity to see some of the finest figurines, vases, and pottery in the world. These finely wrought pieces will be on display in the ceramic exhibit at the 1939 California World's Fair. Included in the exhibit will be 100 pieces selected from the National Ceramic Exhibition.

Balancing the American material will be examples of the work of Europe's greatest artists, such as the Job ceramic art from Sweden; Saxbo stoneware from Copenhagen, done by Krebs; and the Raoul Dufy ceramics (the latter to be shown in America for the first time).

California artists will be well represented in the exhibit. Walter K. Titze, San Francisco, will show a plate entitled "A Fable"; Herbert H. Sanders, San José State College, a bowl speckled with incised rings and a white glazed duck and gray vase; Adolf Odorfer, Fresno, two sculptures, "Pegleg" and "Juan Vicente Gomez"; and William Manker, Claremont, Calif., two bowls.

Glen Lukens, University of Southern California, will show "Water of the Sea," a bowl, two terra cotta jars, a black and green bowl, and a bowl of rose tourmaline.

Sorchu Boru, Menlo Park, who will be in charge of the ceramic atelier in the Palace of Fine Arts, will have a figure of Stalin in the exhibit; Max D. Compton, Los Angeles, offers an opium bowl of copper red glaze; and Ilse Hamann, San Diego, has done a mug with turquoise inside glaze. Two other Californians, Mary Y. Hodgdon, Fullerton, and Laura Anderson, San Bernardino, will also exhibit.

Pieces from other sections of the United States will be "Sun Tanned Godiva" by Irene Anabel Aitken, Cleveland; "Hockey" and "Polo," plaques by Russell Barnett Aitken, New York; a cookie jar by Arthur E. Baggs, Columbus, Ohio; and two sculpture figurines, "Hunter" and "Sun Bather," by Thelma Frazier, Cleveland.

William M. Milliken, Director, Cleveland Museum of Arts, who was chairman of the Jury of Selection for the California World's Fair display, wrote to Mrs. Liebes, Exposition Director of Decorative Arts, that "the show chosen for the Exposition will hit a new high in decorative ceramics."

The choice also was praised by Roland J. McKinney, Exposition Director of Contemporary American Paintings, another member of the Jury.

STRUCTURAL CLAY PRODUCTS SHORT COURSE AT IOWA STATE COLLEGE

T. W. Garve, Columbus, Ohio, will be the principal speaker at a Structural Clay Products Short Course at Iowa State College, Ames, Iowa, February 8 to 10, 1939.

The Short Course is under the direction of the Engineering Extension Department, but it is handled as part of the work of the Department of Ceramic Engineering.

The program is designed to meet the needs of executives, superintendents, foremen, and plant engineers and is limited to problems of interest to producers of construction materials. There are no fees. Ames, Iowa, has ample accommodations for those attending the meeting.

—Paul E. Cox

Distinguished 1938 Service Record Is Now History

It Betters the 1937 Record by

102 Paid Personal Members
2 Paid Sustaining Corporations
66 Paid Subscribers
184 Total Circulation

To this number of interested persons, the American Ceramic Society sends three publications each month, (1) *Journal*, (2) *Ceramic Abstracts*, and (3) *The Bulletin*.

In 1938, THE SOCIETY published in the *Journal* a total of 411 pages; in *Ceramic Abstracts*, 449 pages; and in *The Bulletin*, 504 pages; together these serve as working tools for promoting ceramic art, science, and technology.

PAID MEMBERSHIP RECORD

Date of Record	Members Paid		Deferred	Subscriptions	Monthly Sales	Total Circulation
	Personal	Corporation				
December 20, 1936	1452	196				
December 22, 1937	1713	220	12	523	220	2688
January 22, 1938	1712	220	12	530	220	2694
February 18, 1938	1728	217	15	540	220	2720
March 18, 1938	1770	216	10	513	220	2729
April 18, 1938	1635	205	60	527	220	2647
May 19, 1938	1643	208	52	548	220	2671
June 21, 1938	1675	210	49	563	220	2717
July 19, 1938	1687	212	41	573	220	2733
August 19, 1938	1701	214	37	574	220	2746
September 19, 1938	1738	216	37	580	220	2791
October 19, 1938	1780	215	27	577	220	2819
November 19, 1938	1801	216	27	584	220	2848
December 19, 1938	1815	222	26	589	220	2872

How about 1939?

NEW MEMBERS

Corporation

FAIRFACTS COMPANY, INC., Merwin P. Mitchell (voter), P. O. Box 374, Trenton, N. J.
FORDS PORCELAIN WORKS, I. A. Hansen (voter), Perth Amboy, N. J.
LIBBEY-OWENS-FORD GLASS CO., H. H. Baker (voter), Toledo, Ohio.
METRO GLASS BOTTLE CO., R. R. Underwood (voter), 135 West Side Ave., Jersey City, N. J.
*MOORE ENAMELING & MFG. CO., Walter B. Moore (voter), West Lafayette, Ohio.
PACIFIC TILE & PORCELAIN CO., John Billenstein (voter), 3428 West Pico St., Los Angeles, Calif.
STANDARD LIME & STONE CO., J. D. Baker (voter), 2000 First National Bank Bldg., Baltimore, Md.

Personal

BAER, JOHN G., 121 Kellogg St., Elsinore, Calif.; ceramic engineer, Los Angeles Brick & Clay Products Co.
BARR, JAMES A., JR., 3012 Sunset Drive, Apt. 12-A, Olentangy Village, Columbus, Ohio; sales engineer, Kaolin, Inc.
BHAGAT, M. G., 11 Rawdon St., Calcutta, India; managing director, Bengal Potteries, Ltd.
BURGNER, ARTHUR J., Canadian Potteries, Ltd., St. Johns, Quebec, Canada.
FERVIER, A. F., Monongahela System, Wellsburg, W. Va.; industrial engineer.
GLOSSBRENNER, D. I., 1511 West Washington St., Indianapolis, Ind.; secretary-treasurer, Kaolin, Inc.
HURLBUT, FRANCIS J., "High Trees," Eccleston Park, Prescot, Lancashire, England; chemical engineer, United Glass Bottle Manufacturers.
JANATKA, RICHARD G., Neilwood Gables, Woodruff & Neil Aves., Columbus, Ohio; general sales manager, Kaolin, Inc.
LILLY, ADAM, 4022 Deal St., East Chicago, Ind.; Illinois Clay Products Co.
STOCKBRIDGE, CHARLES, 559 Connecticut St., Gary, Ind.; Illinois Clay Products Co.
SWEITZER, MARK, Scio Pottery Co., Scio, Ohio; ceramist.
WEBBER, MRS. RICHARD H., 429 Lake Shore Rd., Grosse Pointe, Mich.
WILSON, GEORGE, Glenmoor, East Liverpool, Ohio; manager, New Castle Refractories Co., Newell, W. Va.

Student

New York State College of Ceramics: CLARKE, FORD K., KNAPP, WILLIAM J., SCHRICKEL, HERMAN H., WEIDMAN, V. WESLEY, AND WESSELS, EDWIN W.
Pennsylvania State College: MORRIS, GEORGE J., AND SCOTT, ROGER F.
University of Saskatchewan: PRIEST, HARRY C., AND SOUTHEY, THOMAS W.
Georgia School of Technology: NUNES, J. L.

MEMBERSHIP WORKERS' RECORD

Corporation

R. M. Bowman	1	G. S. Diamond	6

Personal

James Barr	1	J. T. Robson	1
G. S. Diamond	1	Mrs. W. B. Stratton	1
A. F. Greaves-Walker	1	W. E. S. Turner	1
J. W. Hepplewhite	1	E. P. Wright	1
A. S. Nichols	2	Office	3

Student

R. M. Campbell	5	Lane Mitchell	1
E. C. Henry	2	W. G. Worcester	2
		Grand Total	**30**

* Indicates former member of Society rejoining.

ROSTER CHANGES DURING DECEMBER*

Personal

CRANDALL, JAMES R., Central Research Labs., American Smelting & Refining Co., Barber, N. J. (Maurer, N. J.)
FISK, HENRY G., 5233 S. Cornell Ave., Chicago, Ill. (Los Angeles, Calif.)
HUEBNER, RICHARD H., Board of Education, Shreveport, La. (Columbus, Ohio)
KNECHT, ALBERT O., 120 E. Palmer Ave., Collingswood, N. J. (New Castle, Pa.)
KOENIG, JOHN H., Hall China Co., East Liverpool, Ohio (Columbus, Ohio)
ROSLUND, JAMES A., National Fireproofing Corp., East Canton, Ohio (Haydenville, Ohio)
SLAUGHTER, JAMES A., New Crystal Hotel, Crystal City, Mo. (Tarentum, Pa.)
VADHANA, S. T., 649-T Chalermlah Bridge District, Amphur Dusit, Bangkok, Siam (Washington, D. C.)
WALLACE, WILLIAM W., Camden Pottery Co., Camden, N. J. (New Castle, Pa.)
WILLIAMS, ARTHUR E., 1896 Julien Ave., Dubuque, Iowa (Berwyn, Ill.)

* Address in parentheses is the former address.

BALTIMORE-WASHINGTON SECTION

The Baltimore-Washington Section held its fall meeting at the Kennedy-Warren in Washington, D. C., November 19, 1938.

Carl Whiting Bishop, associate curator of the Freer Gallery of Arts, spoke on "China's Past as Revealed in Her Ceramics." Much of the material presented in this talk was collected by the speaker during many years spent in China on expeditions for the University of Pennsylvania Museum and for the Freer Gallery of Arts. This subject matter plus Mr. Bishop's recognized ability as a lecturer provided an unusually entertaining and instructive evening.

N. V. Raghunath of Bangalore, India, was presented to the gathering by W. A. Weldon. The assembly of forty-two listened with interest to Mr. Raghunath's brief summary of conditions in his native land and his impressions of America.

—DONALD HUBBARD, *Secretary*

CENTRAL OHIO SECTION

The Central Ohio Section of the American Ceramic Society met in Lord Hall, Ohio State University, on November 15, 1938. T. W. Garve, consulting engineer, gave an illustrated talk on "The Circle System for the Manufacture of Brick and Tile." The talk covered the construction details of this new type of plant.

—R. P. GRAHAM, *Secretary*

PITTSBURGH SECTION*

At the meeting held November 8 in the auditorium of Mellon Institute, the following officers were elected for 1939:

Chairman: Ernest Hommel, O. Hommel Co., Pittsburgh, Pa.
Vice-Chairman: J. R. Beam, Universal Sanitary Mfg. Co., New Castle, Pa.
Secretary: C. L. Thompson, Harbison-Walker Refractories Co., Pittsburgh, Pa.
Treasurer: J. W. Hepplewhite, E. M. Knowles China Co., East Liverpool, Ohio.

—C. L. THOMPSON, *Secretary*

*A notice of this meeting was published in *Bull. Amer. Ceram. Soc.*, **17** [12] 479 (1938).

THE INSTITUTE OF CERAMIC ENGINEERS

The officers of the Institute for 1938–1939 are *President:* Arthur F. Greaves-Walker; *Vice-President:* J. L. Carruthers; *Honorary Past-President:* F. L. Steinhoff; *Secretary:* C. M. Dodd; and *Trustee Representative:* Raymond E. Birch. These officers comprise the Executive Committee.

Information Please

The important function of keeping the membership of the Institute well informed of its activities has been largely neglected in the face of other seemingly more urgent demands. However, beginning with this issue of *The Bulletin*, it is planned to publish each month news concerning the Institute and of affairs of particular interest to ceramic engineers.

The Institute of Ceramic Engineers was organized (1) to promote the professional status of ceramic and other engineers engaged in all branches of the ceramic industry, (2) to promote and improve ceramic engineering education, and (3) to promote the professional development of young engineers in the ceramic industry after graduation. The furtherance of these ideals calls for a program of coöperation with other engineering societies and groups. These aims follow the pattern along which the older engineering societies have been working. One of the objects of these news columns will be to provide means of following the correlating activities of these societies. It has been pleasing to find that these groups have been entirely willing to coöperate with the Institute of Ceramic Engineers.

Institute Membership

The questionnaire answered by several hundred engineers in 1937, when the formation of the Institute was proposed, showed overwhelmingly the desire for a rigid membership plan which would result in a closely knit group of qualified engineers. The founders' group consisted of 156 engineers having a record of at least ten years of professional experience in the ceramic industry.* Subsequently, applications have been received for membership in each grade (Member, Associate Member, and Junior Member). Although the Rules† specify the basic requirements for membership, the application of these rules to any individual application required the establishment of a system of appraisal. In reviewing these first applications, it was considered that every decision served to set a precedent. For these reasons, the Committee on Membership and Examinations has not tried to hurry its work. The committee, with more than 100 applications received within a brief period, is disposing of them as rapidly as time will permit, and a list of the new members will be published each month.

The Committee is prepared to handle applications for all three grades of membership. The Institute can best serve the interests of ceramic engineering if it has the backing of all qualified engineers. The qualifications for membership are given in the Rules,† and additional information may be obtained by addressing A. S. Watts, *Chairman*, Membership and Examination Committee, Ohio State University, Columbus, Ohio.

Accredited Ceramic Engineering Curricula

Although acceptability for membership is based most largely on professional experience, the Rules establish what might be termed a presumption in favor of graduates of departments of Engineering approved by the Committee on Membership and Examinations. This Committee has adopted the policy of giving approval only to those Engineering Departments which have been accredited by the Engineers' Council for Professional Development. The objectives of the E.C.P.D. and its accrediting procedure are explained in an article in this issue of *The Bulletin*.

At the request of the E.C.P.D., the Executive Committee of the Institute some time ago named a representative to serve on the committee for inspection of the ceramic department at Penn State. This department has since been accredited, bringing the total of accredited ceramic engineering departments to eight, as follows:

University of Illinois (technical option)
Missouri School of Mines and Metallurgy
New York State College of Ceramics (Alfred University)
University of North Carolina (Raleigh Branch)
Ohio State University
Pennsylvania State College
University of Washington
Virginia Polytechnic Institute

E.C.P.D. Membership

The Engineers' Council for Professional Development is composed of representatives of the American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, American Society of Mechanical Engineers, American Institute of Electrical Engineers, American Institute of Chemical Engineers, Society for the Promotion of Engineering Education, and National Council of State Boards of Engineering Examiners. Although the Committee has invited the coöperation of the Institute of Ceramic Engineers in certain activities, it is thought that the profession can be best served by acceptance of Institute representatives on the permanent committee organization. Formal application has been made to the E.C.P.D. to grant such representation. It is understood that the Council has referred the application to its Executive Committee.

New Members

A list of the Founders of the Institute was published in *Bull. Amer. Ceram. Soc.*, **17** [3] 128–29 (1938); the list was complete except for the omission of the name of J. Eugene Eagle, Pittsburgh, Pa.

Members

Alexander Silverman, Dept. of Chemistry, Univ. of Pittsburgh, Pittsburgh, Pa.
David C. Zimmer, Patterson Foundry & Machine Co., East Liverpool, Ohio.
Emerson P. Poste, Consulting Chemical Engineer, 309 McCallie Ave., Chattanooga, Tenn.
Samuel Geijsbeek, Geijsbeek Engineering Co., Arctic Bldg., Seattle, Wash.
James R. Beam, Universal Sanitary Mfg. Co., New Castle, Pa.

Associate Members

Albert H. Couch, Libbey-Owens-Ford Glass Co., Rossford, Ohio.
Stephen T. Spires, North American Refractories Co., Womelsdorf, Pa.
Walter R. Schlehr, Carr-Lowrey Glass Co., Westport, Baltimore, Md.
Karl Schwartzwalder, A C Spark Plug Div., General Motors Corp., Flint, Mich.
Walter C. Rueckel, Battelle Memorial Inst., Columbus, Ohio.
Edward P. McNamara, Div. of Mineral Industries Extension, State College, Pa.
Richard O. Lane, Macklin Co., Jackson, Mich.
Walter D. Ford, Ford Ceramic Arts, Inc., 4591 N. High St., Columbus, Ohio.
Emerson W. Emrich, R. T. Vanderbilt Co., Inc., 230 Park Ave., New York, N. Y.
Charles F. Derrer, Jr., Wheeling Tile Co., Wheeling, W. Va.
Gordon R. Pole, TVA Dept. Chemical Engineering, Wilson Dam, Ala.

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* They also have degrees from recognized engineering schools.

† Rules of the Institute of Ceramic Engineers, *Bull. Amer. Ceram. Soc.*, **17** [10] 395–98 (1938).

Paul G. Herold, Dept. of Ceramic Engineering, Mo. School of Mines, Rolla, Mo.
Louis H. Berkelhamer, Saranac Lab., P. O. Box 551, 7 Church St., Saranac Lake, N. Y.

Junior Members

Edwin L. Phillips, H. C. Spinks Clay Co., 502 Monmouth St., Newport, Ky.
John Ogden Reid, 622 Bergen Ave., Jersey City, N. J.
Stuart C. Schatz, Whitehall Sewer Pipe & Stoneware Co., Whitehall, Ill.

ACCREDITED ENGINEERING CURRICULA

Program of the Engineers' Council for Professional Development*

(1) Organization and Objectives of E.C.P.D.

The Engineers' Council for Professional Development has as its expressed objective the enhancement of the status of the engineering profession. To this end the Council has inaugurated a program dealing with the selection, guidance, training, and recognition of the members of the profession. This program is being carried out under the direction of four operating committees. One of these, the Committee on Engineering Schools, is expected, as part of its broad purpose of assisting in the improvement of the status of engineering education, "to formulate criteria for colleges of engineering, which will insure to their graduates a sound educational background for practising the engineering profession."

One very important aspect of the activities of this Committee is the procedure for accrediting engineering curricula. This phase of its program is intended to offer a single accrediting for the duplicated and uncoördinated procedures that have been used in the past. E.C.P.D., representing the American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, American Society of Mechanical Engineers, American Institute of Electrical Engineers, American Institute of Chemical Engineers, Society for the Promotion of Engineering Education, and National Council of State Boards of Engineering Examiners, is in a position to accredit engineering curricula under properly inclusive auspices.

E.C.P.D. is merely authorized by its constituent organizations to publish a list of accredited engineering curricula for use as desired by those agencies which require such a list. It has no authority to impose any restrictions or standardizations upon engineering colleges nor does it desire to do so. On the contrary, it aims to preserve the independence of action of individual institutions and to promote the general advancement of engineering education thereby.

Consideration of curricula with a view toward accrediting is done at the invitation of the institution.

(2) Basis for Accrediting

The basis on which accrediting of engineering colleges is conducted has previously been given in detail.†

(3) Accrediting Procedure

An institution desiring accrediting of any or all of its undergraduate curricula which lead to a degree in engineering may communicate directly with the E.C.P.D. Committee on Engineering Schools. Arrangements will then be made for securing information by questionnaire and for an inspection of the educational facilities of the institution by a regional subcommittee.

Each committee of inspection is selected from the membership of the regional committee, operating in the area in which the institution is located, on the basis of the curricula to be considered. The visiting committee reports its findings to the regional committee, which after consideration of all available information submits to the Committee on Engineering Schools a set of tentative recommendations. Final decision as to accrediting rests with the E.C.P.D., which passes on the recommendations made to it by the Committee on Engineering Schools.

(4) Scope of Accredited List‡

This list includes only such undergraduate engineering curricula as have been judged by E.C.P.D. to be worthy of accrediting. It does not include certain specialized curricula submitted for consideration, which, though apparently outstanding in restricted fields, are not closely related to engineering as it is interpreted by E.C.P.D.

In some cases, accrediting has been made provisional for a limited period (from 1 to 3 years), with reappraisal stipulated at the end of the period. The provisional nature of the accrediting is based upon conditions which E.C.P.D. has not found to be entirely satisfactory but which may be quickly improved or conditions which are now satisfactory but whose future appears precarious. Such conditions include (1) uncertainty as to financial status, (2) need for minor additions to staff or equipment, (3) curriculum new or in state of transition, (4) uncertainty due to nature of administrative organization, and (5) unusual dependence upon strength of a single individual. In every case where provisional accrediting has been granted, the institution has indicated that an effort will be made to remedy the unsatisfactory condition within the stipulated period of provisional accrediting. The fact that accrediting may thus be provisional is, in each case, a confidential matter with E.C.P.D.

(5) Provision for Reinspection and Review

The list of curricula which have been accredited by E.C.P.D. is to be revised annually. Through its Committee on Engineering Schools, E.C.P.D. will keep currently informed relative to significant changes in curricula, staff, facilities, organization, enrolment, etc., in institutions where curricula have been accredited and will arrange to have certain institutions revisited each year.

Requests for further information relative to E.C.P.D. and the accrediting program may be addressed to S. L. Tyler, Secretary, Engineers' Council for Professional Development, 29 West 39th Street, New York, N. Y.

‡Published in *Jour. Engineering Education*, October, 1937.

NECROLOGY

LUCIEN DELLOYE

Lucien Delloye, elected to Honorary Membership in the American Ceramic Society in March, 1938, passed away December 26, 1938. The news was received by cablegram from Bernard Long sent to Alexander Silverman of Pittsburgh, Pa. A biographical sketch of Dr. Delloye was published in *The Bulletin* in May, 1938.* In the July, 1938, *Bulletin*, an account was published of the presentation of the Honorary Membership certificate by Dr. Silverman. Dr. Delloye at that time was seriously ill with a heart attack, and the diploma was presented by proxy to his son André.†

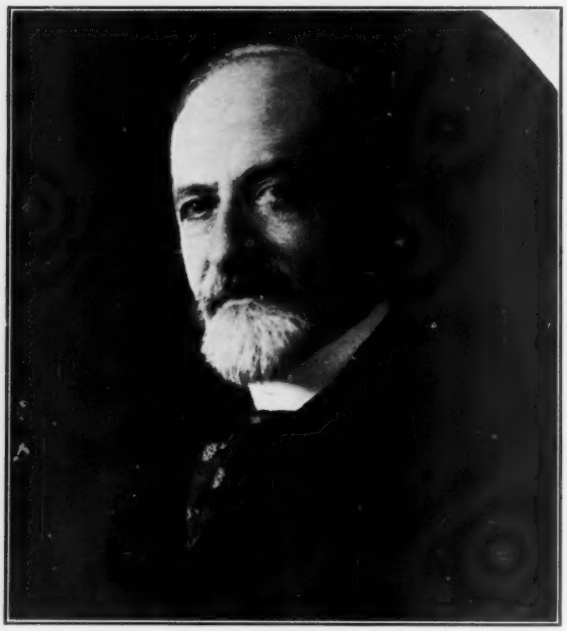
The ceramic industry, particularly members of the Glass Division, will feel deeply the loss of Dr. Delloye.

* From material presented in the *Jour. Engineering Education*, **27** [New Series, No. 2] 1–4 (1937).

† Report of the Committee on Ceramic Education for 1936, *Bull. Amer. Ceram. Soc.*, **16** [3] 111–115 (1937).

* "Lucien Delloye—Honorary Member," *Bull. Amer. Ceram. Soc.*, **17** [5] 228–29 (1938).

† "Presentation of Honorary Membership Diploma to Lucien Delloye," *ibid.*, **17** [7] 298 (1938).



Lucien Delloye

Louis P. Collin

LOUIS P. COLLIN

Louis P. Collin, Ceramic Engineer of the Bureau of Mines, Department of Mines and Resources, Ottawa, Canada, died after a lengthy illness, on November 26, 1938.

Mr. Collin, who was in his fortieth year, was born at Red Hook, N. Y., the son of Mr. and Mrs. Eli Collin. He attended Alfred University, graduating from there with the degree of B.Sc. in 1920.

On graduation he joined the engineering staff of the Dressler Tunnel Kiln Co. The following year he went to Alcoa, Tenn., as superintendent of the brick plant of the Aluminum Company of America. In 1923, he was appointed to the ceramic staff of the Canadian Department of Mines at Ottawa, where he conducted a number of investigations on structural clay products and also on special porcelains.

Surviving him, in addition to his widow, formerly Miss Jean Baxter, are two sons, Robert and Baxter, and one sister.

Mr. Collin was a member of the American Ceramic Society for a number of years, and he also served as an abstracter for *Ceramic Abstracts*.

PRESIDENT'S COLUMN

AUTUMN MEETINGS—NEW MEMBER INTEREST

The various Division meetings held during the autumn of 1938 probably marked a new high in attendance, interest, and number of papers presented.

Starting early in September and closing during the latter part of October, each of the Divisions presented programs of unusual interest and merit. The quality and timely interest of the papers presented by the different Divisions are contributions of practical value and application to ceramic arts and sciences.

Good fellowhip prevailed throughout the meetings which added greatly to the general interest.

The autumn meetings are gaining in importance and therefore merit and demand greater consideration from the general membership of THE SOCIETY.

The autumn Division meetings in the future may prove to be a suitable clearing medium for the presentation of progress reports by the various committees. At the Annual Meeting, inasmuch as the time factor is limited, the committees do not always have as much time as is required to review the committee work. A mid-year report at the autumn sessions should therefore prove helpful.

Another function of the autumn meetings may be devoted to considering ways and means of increasing the membership of THE SOCIETY. The Division members may find it convenient to invite a number of nonmembers to these Division meetings, and this would no doubt stimulate interest in the minds of the prospective members.

It is necessary for THE SOCIETY to be able to meet the increasing demands being made upon it, which necessarily increases its operating cost. Therefore, ways and means must be developed to meet the increasing requirements upon THE SOCIETY'S personnel and resources. Adding to the number of members, both personal and corporation, is one approach to the solution of this problem.

It may be argued there are certain objections to a large membership because it is difficult to stimulate interest on the part of many members in a large organization and, furthermore, because of the rather scattered interests of a large membership, it may be difficult to concentrate the activities of THE SOCIETY in the hands of many members. These objections may be more fancied than real.

Irrespective of arguments to the contrary pertaining to increasing the number of Corporation and Personal

Memberships, it is necessary to have sufficient income to meet the pressing cost of operation.

Mr. Diamond, Chairman of the Membership Committee, has presented a number of arguments in seeking new members and has done good work in securing new members. Your assistance in this connection is solicited.

—VICTOR V. KELSEY

ENAMEL BIBLIOGRAPHY

The Enamel Division of this Society, under the leadership of George H. Spencer-Strong and Jacob E. Rosenberg, is preparing a Bibliography of World-Wide Literature on Enamels, covering the years 1928 to 1938, inclusive. E. H. McClelland, Technical Librarian at Carnegie Library, Pittsburgh, is making the compilation. The editorial work, including compilation of magazine names and addresses, also a subject index, will be done by Emily C. Van Schoick, Assistant Editor for THE SOCIETY. The business transactions with the printer and the sales of the Bibliography will be handled by THE SOCIETY. Subscriptions and contributions will be collected by the Enamel Division committee appointed for this purpose.

Because questions have been asked as to the contributions of money and services by THE SOCIETY at large to the issuance of the Enamel Bibliography, compiled by Robert D. Landrum and Herbert D. Carter and issued in May, 1929, a condensed ledger record is here given. All the editorial and business transactions were handled at the Society's executive office. The Journal list and Index were made by Miss Van Schoick and checked by Mr. Landrum.

Ledger Account

1928–1929

Printing costs	$2928.92	Contribution and sales	$2740.24
Editorial and incidental	801.07	Inventory	355.00
		Profit and loss write-off	634.75
	$3729.99		$3729.99

1930–1935

Inventory	$355.00	Sales	$228.55
		Profit and loss write-off	126.45
			$355.00

Total write-off or loss absorbed by THE SOCIETY was $761.20.

BUILDING MATERIALS RESEARCH

Harold E. Simpson Appointed

Edward R. Weidlein, Director, Mellon Institute, Pittsburgh, has announced the establishment of an Industrial Fellowship in that institution by the United States Gypsum Co., Chicago, Ill. This Fellowship will conduct fundamental research on various products manufactured by the donor company, with the objective of developing new processes and techniques which will have broad application in the field of building materials. This investigational work will augment the regular research activities carried on by the donor.

H. E. Simpson, who has been appointed to the incumbency of the Fellowship, has been a member of Mellon Institute since 1936. He received his professional education at the Ohio State University (B.Cer.E., 1925; M.S., 1926; Ph.D., 1929). He served as assistant professor in the ceramic department at Rutgers University in 1930 and, during the period 1930 to 1936, he was research engineer for the Battelle Memorial Institute, Columbus, Ohio. Since then Dr. Simpson has been on the staff of the Multiple Fellowship on glass technology in Mellon Institute.

CERAMIC SCHOOL NOTES

NEW YORK STATE COLLEGE OF CERAMICS

The New York State College of Ceramics Student Branch, American Ceramic Society, held its second meeting of the year on November 29, 1938.

Emerson P. Poste, Chattanooga, Tenn., spoke on "Twenty-Five Years with Vitreous Enamels." In his talk, which was supplemented with moving pictures, Mr. Poste reviewed the enameling industry, with its trials and tribulations, from its incipient status up to modern times, with a thorough elaboration on the difficulties encountered at present. In this review, Mr. Poste showed advancement which this particular industry has made even within the last few years.

There were approximately 180 persons in attendance, many of whom were not directly connected with ceramics.

—MARTIN E. DYKEMAN, *Secretary*

PENNSYLVANIA STATE COLLEGE

The third meeting of the Pennsylvania State College Student Branch, American Ceramic Society, continues the varied and interesting programs being presented this year. Dr. Kreidel, who was formerly in charge of three glass plants in Czechoslovakia and who recently came to the United States, spoke; he also read an interesting discussion relating to the glass industry in his home country.

The first week in December, W. E. S. Turner, Sheffield, England, talked of the changes he had seen in the glass industry since his last visit to the United States, seven years ago.

At the meeting of the Student Branch held December 15, 1938, Dr. Dengler of the classical language department, Penn State College, spoke on ancient ceramic art. Following the meeting, a cabin party was held, with W. P. Bramlett, social committee chairman, in charge.

Officers for 1938–1939 are as follows: *President*, Kenneth S. Cowlin; *Vice-President*, Bruce Trumm; and *Secretary-Treasurer*, Joseph D'Amico.

—KENNETH S. COWLIN

RUTGERS UNIVERSITY

The Rutgers Ceramics Club and Student Branch of the American Ceramic Society met Monday, November 21, 1938, in the Ceramics Building at Rutgers University.

The guest speaker for the evening was John B. Maddock, Paper Makers Importing Co., Easton, Pa., who spoke on "Production of China Clays in Cornwall" and "Ball Clays of Devon and Dorset, England." Mr. Maddock, who has spent eight years in the production of high-grade clays in England and is an authority in that field, discussed the various phases of clay mining, refining, and shipping. His talk was illustrated with lantern slides.

At the first open meeting of the Ceramics Club on November 3, Mathew J. Scammell, Scammell China Co., Trenton, N. J., who has recently returned from Europe, spoke on his observations of the recent economic disturbances in Europe and their effect on the ceramic industries.

The Rutgers Ceramics Club and Student Branch of the American Ceramic Society held a gala Christmas dinner and party on the evening of December 15, 1938, in the Assembly Room of the Ceramics Building, Rutgers University, New Brunswick, N. J. The affair, a highly successful one, was attended by approximately sixty persons, representing the faculty and student body of the Department of Ceramics.

The dinner, featured by kiln-roasted turkey, opened the evening. All types of entertainment followed, including motion pictures, games, music, and, of course, gifts from Saint Nick himself.

—Gilbert Goodman, *Recording Secretary*

LETTERS TO THE EDITOR

VALUE OF SOCIETY MEMBERSHIPS

December 2, 1938

"Membership in the American Ceramic Society has proved far more valuable to my work and pleasurable to me personally than I ever imagined it could. It has immensely broadened resources for study and has proved an Open Sesame in many places where I could scarcely have ventured. One realizes how much it means to the research man, the practical manufacturer, the artist or the student, who is just attaining mastery of his difficult subject. I shall never be any one of these gentry, but I find the literature of the Society an inexhaustible mine of things I need to know, and the kindness of the members equally unfailing."

—ANNA LANE DIXON

EDITOR'S NOTE: Mrs. Dixon is curator of pottery, porcelain, and glass for the Iowa Federation of Women's Clubs, Burlington, Iowa. She hopes that the ceramic studies carried on by the women of Iowa can be extended to other state federations.

Student Appreciation of Society Membership

December 6, 1938

"Enclosed you will find the necessary $5.00 for the continuation of my subscription to the publications of the American Ceramic Society.

"May I say that, young and inexperienced as I am, the *Journals* and *Bulletins* have been a real value and source of pleasure to me. You may realize just how much by noticing that Christmas is just three weeks away and that this subscription leaves me flat broke!"

—RICHARD L. WELCH, *University of Saskatchewan*

ANOTHER GIFT TO THE SOCIETY

Howells Fréchette, Chief, Industrial Minerals Division, Canadian Department of Mines and Resources, has presented to THE SOCIETY 64 volumes of the *Transactions of the American Institute of Mining and Metallurgical Engineers*. Inclusive volumes of the Institute of Metals Division from 1927 to 1938 are included in this gift. The volumes of the *Transactions* are as follows: I–VII, X–XIII; Index, I–XV; Volumes XVIII–XX, XXII–XXIX; Index, XI–XXV, XXVI–XXX; and Volumes XLII–LXXVI (1938).

In sending this gift, Mr. Fréchette states: "I am very conscious of my deep debt to the American Ceramic Society for much that I have received, and I wonder if I can discharge this debt to a slight extent by giving to your library my *Transactions of the American Institute of Mining and Metallurgical Engineers*."

Members of the American Ceramic Society are grateful to Mr. Fréchette for this fine addition to the Society library, which is rapidly increasing in value.

OPPORTUNITY TO PROMOTE CERAMICS

The Coöperative Visual Education Center, sponsored by the State Department of Education and operated by the WPA, has for its function the preparation of all types of visual education materials which have proved useful in a modern education curriculum. These materials are used in connection with a central exhibit and production service for the schools of Connecticut.

The Library Display Department is especially interested in literature and materials that describe the process of making all types of articles from the raw to the finished product. The Art Department is able to mount in attractive display materials sent to this Center.

It is understood that the members of the American Ceramic Society have education materials of this type available to schools. Can you send to the Center a complete set, together with a statement as to the basis and extent to which they may be available to individual schools?

These materials would be placed in the Library Display Room, which is visited throughout the school year by visual education specialists. Although there are no funds for these displays, the specialists mentioned can and do pay for display material for their classes. In this respect, they are rendered a distinct service as well as the commercial firms who assist in this work.

Assistance in this visual education program by the American Ceramic Society will be greatly appreciated. Address communications to The State Department of Education, 274 George St., New Haven, Conn.

—MARION CLARK, *Library Display Department*

MOTION PICTURE-CONSUMER EDUCATION

A program of motion picture-consumer education is being planned by the Federal Department of Commerce. The plan will follow closely that used by the U. S. Bureau of Mines, which has sponsored films depicting progressive methods in the utilization of our varied mineral resources.

The Department of Commerce, with the assistance of the U. S. Chamber of Commerce and its affiliated Chambers, will distribute films designed to "dramatize the aims, processes, and ideals of American industry." This is likely to appeal to trade associations in particular, inasmuch as it is not the desire of the Government to advertise various brands.

"From Washington and decentralized depositories, the films will always be available for showing on request *free* to schools, clubs, churches, etc., everywhere. Because prints are owned by the Government, they can be shipped under the Government frank. Likewise, circulation of descriptive literature, bulletins, and posters to stimulate bookings and attendance, will be sent out. . .

"The plan is to set up a nonprofit organization operating within the Department for the purpose of handling all funds in connection with procurement of prints, distribution, promotion, servicing, etc., of these films. It may simplify procedure if advances for production costs are made through the Department of Commerce."

This announcement is an opportunity for ceramic industries to enjoy further promotion and advertisement through Federal aid. For further information and details of the plan, refer to Frank R. Wilson, Assistant to the Secretary, Department of Commerce, Washington, D. C.

The Film Library Committee for THE SOCIETY is as follows: H. E. Simpson, *Chairman;* F. B. Hobart, and Ross C. Purdy.

F. F. RUPERT ON AIR-FILTER RESEARCH

The American Air Filter Company, Inc., Louisville, Ky., Fellowship at Mellon Institute, Pittsburgh, Pa., will investigate broadly the materials of value in the construction of filters for air-conditioning systems. It will be the aim to gain through this research new knowledge to effect all possible improvements in the devices manufactured by the donor, and in this work the Fellowship will have the direct coöperation of specialists on the staff of the Multiple Industrial Fellowship on air hygiene in operation in the Institute.

Frank F. Rupert has been a member of Mellon Institute since 1913. He received his professional education at the University of Kansas (A.B., 1906; A.M., 1908) and at the Massachusetts Institute of Technology (Ph.D., 1912). He served as instructor in chemistry at the University of Kansas previous to 1912, and during the period 1912–1913 he was junior physical chemist in the U. S. Bureau of Mines. Since 1935, Dr. Rupert has been associated with the Fellowship on Air Hygiene in Mellon Institute.

CERAMIC HISTORY

STANLEY G. BURT

Stanley G. Burt is a Charter Member of the American Ceramic Society. He served as Treasurer of THE SOCIETY from the time of its organization in 1899 until 1905–1906. During 1907–1908, he was President of THE SOCIETY and has been affiliated with the White Wares Division since its organization.

Mr. Burt has supplied the Editor with only a brief and modest account of the facts of his life. In concluding his letter from Stuart, Fla., where he now makes his home, he stated: "If you can get anything of general interest out of this material you are a wizard.

"What I think would be interesting would be an article I wish I *could* write, 'Then and Now,' telling some of the weird ideas and beliefs I was told by our old English potters when I started back in the early nineties. I don't suppose the young man of today can grasp how little was known about the whole subject. I wish to cite an instance of an encounter with one of our potters.

"'What is whiting?' I asked.

"'Stuff that makes glaze white.'

"'Yes, but what is it?'

"'Why, stuff that makes glaze white.'

"Can I ever forget the old man grinding a frit in an open roller mill to which he had added borax. As the water evaporated and the longer he ground, the bigger the crystals grew.

"'The longer you grind, the worser it gets. Now, I suppose *you chemists* know all about that.'"

Biographical Sketch

Stanley Gano Burt was born May 31, 1870, in Cincinnati, Ohio. He attended the public and high schools in Cincinnati and was graduated from Yale University in 1892. Following his graduation, he went to work at the Rookwood Pottery Company in Cincinnati. During the year 1894, he studied at the Königliche Hochschule in Berlin and later took graduate work at the University of Cincinnati.

At Rookwood Pottery, from 1896 to October, 1929, he served as superintendent of the factory and as chemist, making all bodies and glazes. Mr. Burt brought the first Seger cones to the United States in 1894 and, at the same time, one of the first electric pyrometers. The success of the Rookwood Pottery and the superiority of the products made there testify to Stanley Burt's lifetime accomplishments.

Publications by S. G. Burt in the Transactions of the American Ceramic Society

"Practical Experience with Pyrometers (discussion)," **1,** 29 (1899).

"Transfer of Excessive Heat in the Kiln Mouth to the Kiln Proper in Crude-Oil Firing," **1,** 43 (1899).

"Blistering of Glazes," **2,** 139 (1900).

"Electric Furnace for Ceramic Purposes," **2,** 192 (1900).

"Fineness of Flint in Its Relation to Manufacture of Pottery Bodies," **3,** 17 (1901).

"Fine Grinding of Potters' Materials (discussion)," **4,** 31 (1902).

"Fritting," **4,** 79 (1902).

"Tin Oxide in Ceramic Fluxes," **4,** 139 (1902).

"Coefficient of Expansion of Silica," **5,** 340 (1903).

"Egyptianized Clay (discussion)," **6,** 59 (1904).

"Faience *vs.* Majolica," **6,** 109 (1904).

"Coefficient Equivalents," **7,** 123 (1905).

"Presidential Address," **9,** 51 (1907); **10,** 45 (1908).

"Seger's Rules for Correction of Glaze Defects (discussion)," **13,** 179 (1911).

"Coefficient of Expansion Data on European Porcelain (discussion)," **13,** 422, 427 (1911).

"Sagger Breakage," **13,** 647 (1911).

"Microscopic Examination of Twelve Mat Glazes (discussion)," **14,** 704 (1912).

"Use of Fuel Oil in a Pottery (discussion)," **15,** 664(1913).

Mr. Burt published "Discussion of Terra Cotta Glazes" in the *Journal of the American Ceramic Society*, Vol. 1, p. 365 (1918).

NOTES AND NEWS

INTER-SOCIETY COLOR COUNCIL MEETING

The eighth annual meeting of the Inter-Society Color Council will take place in New York N. Y., February 23, 1939. (During that same week two member bodies have meetings in New York: the Technical Assn. of the Pulp and Paper Industry and the Optical Society of America.)

The general program will consist of a morning business session at which committee activities will be reported, an afternoon technical session on the subject of "Color Tolerances," co-sponsored by the American Psychological Assn., and an evening session to consist of short popular demonstrations sponsored by individual member societies. In connection with the afternoon session, there will be an exhibit.

Business Session (February 23, 1939, 9:30 A.M.)

Reports of committees, particularly the report of the Problems Committee, Deane B. Judd, *Chairman*.

Technical Session on Color Tolerances (2:00 P.M.)

This meeting is sponsored jointly by the Inter-Society Color Council and the American Psychological Association; *Chairman*, Forrest L. Dimmick, Hobart College.

(1) "Physics of Color Tolerances," by Deane B. Judd, National Bureau of Standards, Washington, D. C.

The physicist evaluates color differences operationally in a standard coördinate system; perceptibility of color difference is relatively unimportant in tolerance consideration.

(2) "Psychophysics of Tolerances," by Edwin G. Boring, Harvard University, Cambridge, Mass.

The fundamental significance of the psychophysical methods and techniques in the evaluation of small sensory differences.

(3) "Ratio Method in the Review of the Munsell Colors," by Sidney M. Newhall, Johns Hopkins University, Baltimore, Md.

A promising application in a different field of a psychological method which is being used in color tolerance determination.

(4) "Color Tolerances as Affected by Changes in Composition and Intensity of Illumination and Reflectance of Background," by Harry Helson, Bryn Mawr College.

Typical data illustrating lawful relationships between the hue, saturation, and lightness of surface colors and principal conditions of viewing.

(5) "Representation of Color Tolerances on the Chromaticity Diagram," by David L. MacAdam, Eastman Kodak Co., Rochester, N. Y.

The ICI coördinate system is recommended for color tolerance representations; use of a coördinate system,

based on just noticeable color difference data, would be unjustified and misleading.

(6) "Specification of Color Tolerances at the National Bureau of Standards," by Deane B. Judd.

Color tolerances have been applied by (1) specification of a mixture diagram, (2) use of a standard tolerance and sample, and (3) use of the "NBS unit of surface-color difference."

(7) "Industrial Color Tolerances," by Isay Balinkin, Cambridge Tile Manufacturing Co., Cincinnati, Ohio.

Techniques and results in the establishment of color tolerances for particular products and purposes, with special reference to ceramics. Control of color uniformity by determination of rates of color variation as a function of various physical or chemical factors.

Popular Session—Parade of Color (8:00 P.M.)

Each member body has been invited to contribute a short demonstration of recent color developments or a research project of outstanding importance to his society, the presentation to be made in a popular manner.

The purpose of the demonstration is to illustrate the color interests of each of the member groups.

The American Ceramic Society is a member of the Inter-Society Color Council and is represented on the Council by the following committee:

V. H. Remington, *Chairman*, B. F. Drakenfeld & Co., Washington, Pa.

F. H. Norton, Massachusetts Institute of Technology, Cambridge, Mass.

C. Robertson, E. I. du Pont de Nemours & Co., R. & H. Chemicals Dept., Perth Amboy, N. J.

R. S. Hunter, Colorimetry Section, National Bureau of Standards, Washington, D. C.

ILLINOIS CLAY MANUFACTURERS MEETING

This meeting was held December 16 and 17, 1938, at Streator, Ill., with a round-table conference on new forms of structural clay products. Special shapes, such as H-brick, double-brick, multiple-cored blocks, and forms of wall, floor, and foundation blocks, were shown and discussed. Manufacturers were asked to bring samples of such articles as they are now making or are developing and also special forms of competitive materials not made of fired clay which they are meeting in the market.

This meeting afforded an opportunity for interchange of ideas and experiences which was of benefit to every manufacturer of structural clay products and those directly concerned with the plant production operations.

—R. K. HURSH, *Secretary*, Urbana, Ill.

AIR HYGIENE MEETING

More than 200 executives from 101 industrial concerns attended the third annual fall meeting of the Air Hygiene Foundation held at Mellon Institute, Pittsburgh, Pa., November 17, 1938. The executives heard reports on latest advances in protecting the health of industrial workmen who lose an estimated 200 million working days yearly because of illness. A dozen state and federal agencies sent special representatives to the meeting.

Reports covered engineering and medical developments during the past year toward employee health improvement, state codes governing health hazards, and legal and economic trends. The program included findings from researches which are being conducted under grants from the Air Hygiene Foundation at the University of Pennsylvania for improving X-ray methods for large-scale medical examinations of industrial workers; the Saranac (N. Y.) Laboratory for studies of "mixed" dusts and "protector" dusts in combating dust diseases; Harvard University for establishment of two graduate fellowships to help build up a qualified personnel of industrial hygienists to meet the increasing demand for these specialists. One incumbent is studying fundamentals of hood design for control of gases, vapors, etc. The other is studying the identification and distribution of dusts in tissues.

CERAMIC CAMERA CLUB

An announcement has been made of the formation of the Ceramic Camera Club, an organization for members of the American Ceramic Society who are interested in photography.

The members of the Club will hold their first exhibition during the Forty-First Annual Meeting of the American Ceramic Society to be held in Chicago, Ill., April 16–22, 1939. Each member may enter from one to four prints and the prints must be submitted on a 16- by 20-in. vertical mount. It is not necessary that the exhibitor send in four prints, but each member may submit not more than four. Those who wish to participate in the Exhibition should notify J. M. McKinley, 1012 National City Bank Bldg., Cleveland, Ohio. Although members do not need to send in prints at the present time, it will be necessary to plan display space, and it is urged that those who have prints for display signify this fact as quickly as possible.

The prints will be submitted early in April, at which time they are to be mailed to a designated address in Chicago where a committee from several of the well-known camera clubs of Chicago will arrange the presentation of the show at the Hotel Stevens.

The proposed club will not interfere with activities of THE SOCIETY. It has been pointed out that quite a number of members of THE SOCIETY have done some very good technical work in ceramics along the lines of photography, and it is hoped that they will accept this opportunity to enroll in the Ceramic Camera Club.

Among those who are members of the Ceramic Camera Club are J. M. McKinley, J. C. Hostetter, J. Earl Frazier, H. M. Kraner, J. T. Littleton, E. L. Hettinger, and Raymond Kerr.

In addition to the Exhibition, which will continue during the entire week of the Annual Meeting, the members hope to plan an informal meeting or dinner.

JOURNAL OF THE SOCIETY OF GLASS TECHNOLOGY

A bimonthly Journal containing the original papers communicated to the Society together with abstracts of other papers covering the whole field of glass technology.

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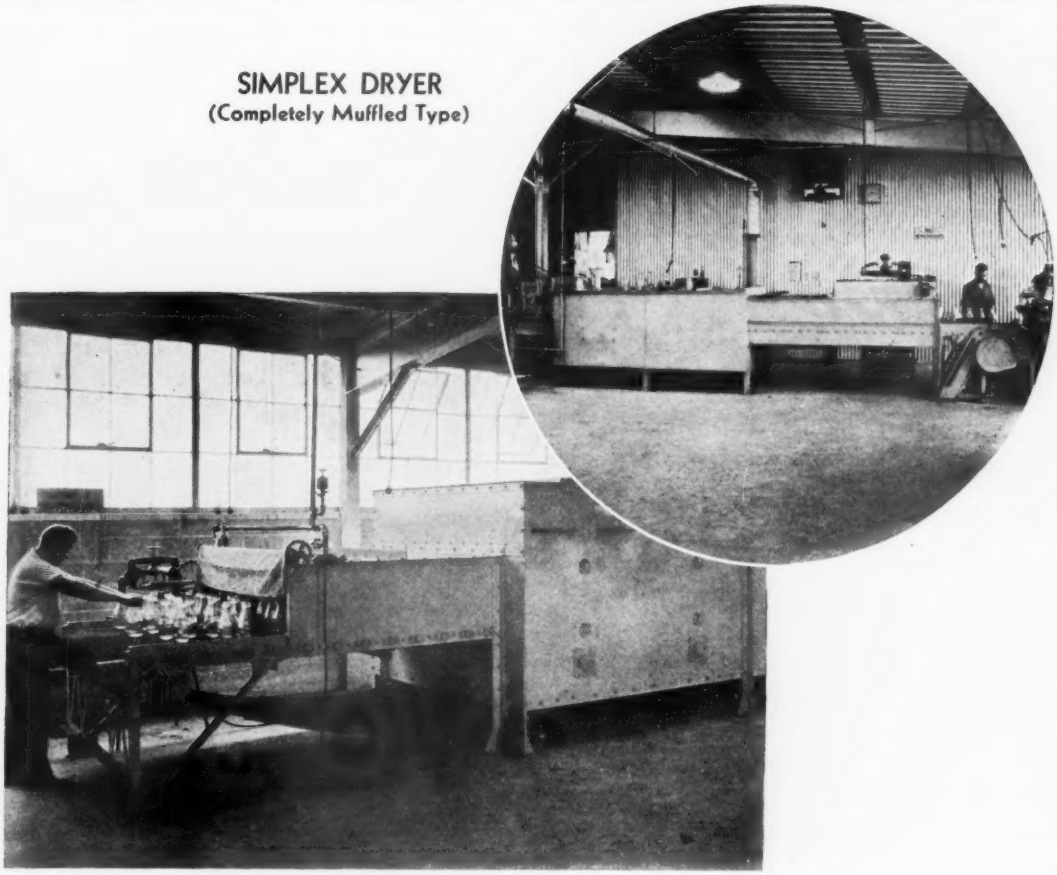

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